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CONTENTS.

EDITORIAL:
Substation Location . . . 1
The Heusler Alloys . . . 1
A Phase of Electric Railway Development . . . 2
Effects and Causes . . . 2
The Oxyacetylene Blowpipe . . . 3
The Utilization of Blast Furnace Gases . . . 3
The Electrical Nature of Matter and Radioactivity, by Harry C. Jones . . 4
Meeting of the Executive Council of the National-Interstate Telephone Association . . . 6
Available Power and Cost of Operation of a Power Station for Waste Gases from a Blast Furnace Plant, by H. Freyn . . . 6
The Chicago Electrical Show . . . 7
The Seventh Annual Dinner of the Olympic Club . . . 8
Electrical Mining Notes, by Sydney F. Walker . . . 8
American Association for the Advancement of Science . . . 9
Swiss Electrolytic Plants, by C. L. Durand . . . 10
Annual Meeting of the Independent Telephone Association of Wisconsin. 12
Some Considerations Determining the Location of Electric Railway Substations, by C. W. Ricker . . . 13
Jhelum River Hydroelectric Power Installation in British India . . . 16
Oscillograph Researches on Surging in High-Tension Lines, by C. David. 17
The Faraday Society . . . 21
Electrical Patents . . . 23
Book Reviews . . . 23
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE . . . 24
The Illuminating Engineering Society . . . 25
METHODS OF GETTING NEW BUSINESS . . . 26
INDUSTRIAL SECTION:
The Dale "Connecttome" . . . 27
Advanced in Window Lighting . . . 27
The Development of Sprague Electric Motors . . . 28
A New Electric Battery . . . 28
New Prime Movers . . . 28
Improved Condensing Apparatus . . . 29
An All-Metal Locker . . . 29
A New Company for the Manufacture of Dry Batteries and Fan Motors . . . 30
The Pedrick & Smith Pipe-Bending Machine . . . 30
CURRENT ELECTRICAL NEWS . . . 31

SUBSTATION LOCATION.

The paper read at the recent meeting of the American Institute of Electrical Engineers by Mr. C. W. Ricker on substation location forms one of those helpful studies of engineering problems which are becoming more and more necessary as the complexity of the problems increases. This paper will be found on another page of the present issue. Mr. Ricker shows how the difficult and important question of the location of substations may be studied graphically, and in this way the best solution obtained. Where there are so many varying factors affecting the question, some one way and some another, a diagram showing just to what extent these enter into the final figures is particularly valuable. This is well brought out in the diagrams which Mr. Ricker employs.

It must not be assumed that any solution obtained in this way can be accepted without question. Generally the local conditions or other factors which can not be represented in the problem by figures determine the final decision, but these analyses aid toward an approximate solution. This is nicely brought out by Mr. Ricker's treatment. He shows that if we follow Kelvin's law for the most economical investment in copper, we reach a solution which would not be practicable, for it would allow too great a drop in the line. We must therefore compromise and invest enough in copper to make the system workable. In every engineering problem there are always factors of this kind. Were it not so, engineering could be reduced to an exact science, and all the designing would be done with a pencil, paper and a slide rule, leaving little for the constructing or operating man to care for except to carry out his written instructions.

THE HEUSLER ALLOYS.

A good deal of interest was excited some time ago by Heusler's discovery that certain alloys containing neither iron, nickel nor cobalt were decidedly magnetic. This fact has brought into question Weber's atomic theory of magnetization, which assumes that the minute particles of the magnetic metals are inherently magnets, and that the magnetization of a piece of metal as a whole becomes apparent when these molecular magnets are arranged in certain positions.

Since Heusler's discovery there is a tendency to attribute the magnetic properties of iron to its physical condition—to a particular form of crystallization, as it were, the atoms being able to arrange themselves in a certain way which gives rise to the magnetic qualities. This theory would explain the loss of magnetization when the iron is heated above a certain temperature, and would also account for the varying permeability of the same piece of metal when it is subjected to different physical treatments. Since the theory does not call for a molecular magnet, to account for the magnetization of metals belonging to another group it will be sufficient to attribute to them the ability to pass into the magnetic condition.

In *L'Industrie Électrique* (Paris) for December 10, M. C. E. Guillaume contributes an interesting study of these Heusler alloys, and offers suggestions. He attacks the problem by explaining first the behavior of the alloys when subjected to heating. As is well known, the temperature of fusion of an alloy is generally lower than that of its constituent metals. There are, however, three important exceptions to this law, namely, the alloys of gold and aluminum, sodium and tin, and antimony and aluminum. The fusing points of these alloys are higher than those of the metals themselves. This fact is thought to be significant, as the Heusler alloys contain either aluminum or tin. The other components of the alloys are manganese and chromium, which elements are assigned to the iron group of elements. May it not be possible, M. Guillaume says, that these latter two

metals could be made magnetic if we could produce the proper condition, which might require a low temperature; and may it not be that the presence of aluminum or tin acts to increase this critical magnetic point, just as they increase the fusing point of the alloys which they form with sodium or antimony? It is considered significant, as well, that the salts of manganese and chromium are decidedly magnetic. The author does not put this forward as a theory, he merely calls attention to these coincidences, which seem to him to indicate that there is an underlying law. A study of the magnetic behavior of the Heusler alloys with changes in temperature will bear directly upon this suggestion and prove of very considerable interest. It might lead not only to facts of scientific importance, but of possible commercial value.

A PHASE OF ELECTRIC RAILWAY DEVELOPMENT.

Some rather interesting phases of railway operation seem to be overlooked, or at least waived for the moment in the interesting discussion now going on between the advocates of different systems. We hear much about the efficiencies of the various systems now in use, and a great deal more about the relative costs of installation. These, it is true, are important factors, but for any system to be introduced on trunk lines or to replace the present method of locomotion on steam roads, it must be, above all, reliable: there must be absolutely no doubt as to the dependence which can be placed upon it. And this confidence can be secured only after the system has been put through an exhaustive test under practical conditions.

These requirements seem to be contradictory, for how, it may be asked, can the reliability of a system be determined until it has been tried; yet the trunk line should not try it until its reliability is known. Fortunately, there are often conditions in which a new system may very properly be installed, with a view to determining its reliability and general good qualities. For a line doing a comparatively small traffic—comparatively, that is, compared with the large steam roads—an occasional break-down of a car does not matter much, as the next car will push it home. Troubles at the station, while unfortunate, do not at once condemn the system, for they are unavoidable in a new system, and it is hardly to be expected that some slight change in the first layout will not be found necessary. The same conditions are met, though in a different degree, on a large city system. It is not a vital matter when one car breaks down—the next will push it in; but here it is of the greatest importance to have no failure at the main station. As the system increases in size the requirements of reliability become greater, but even on such a system as the New York subway delays are not unknown, though the inconvenience is only temporary.

Conditions change, however, when we pass from an urban system, such as those mentioned, to a large railway system operating daily hundreds of suburban trains and many fast through expresses. The breakdown of one suburban train involves a delay of many others, and affects a large number of passengers. The stalling of a through express, while, perhaps, not inconveniencing so many persons, is dreaded even more by the officials of the road. With them the first question is, can we depend upon this system? If so, is it not worth considerably more to us than another system whose record is not so good? What if the latter system be more efficient? One or two breakdowns in a year may cost a good deal more than the system will save. If a change must be made it is far better to put in an expensive but sure system than one costing less but leaving some doubt.

These are questions which naturally have much weight in the selection of a new system for a large road, but for some reason or other one hears little about them in the discussions. It is fortunate that the two systems of electric railroading now under consideration are being tried on such scales as to convince their advocates of their undoubted reliability. Those who have not been fortunate enough to have actual experience with them can only wait for further developments. Before long we will know more about these systems, and we may rest assured that it will not be the most efficient nor even the cheapest system that will win, but the one which proves itself to be the most reliable.

EFFECTS AND CAUSES.

Every little while one encounters brief reports of a supposed wonderful discovery by some hitherto unheard of investigator who thinks he at last has hit upon one of nature's cherished secrets. Discoveries of this kind are reported not infrequently in almost every branch of scientific research, and, naturally, that dealing with the great problem of life has received its full share of attention.

An article describing such a discovery appeared recently, emanating from some point in the Far West. The subject was an old one, for this discovery has been discovered many times before. It was, in effect, a brief description of what is thought to be a proof that life is electricity. The discoverer of this important identity had experimented upon an animal, and, by bringing conducting terminals in contact with the brain or nerves, had been able to detect a slight deflection in a galvanometer connected to these terminals, which therefore indicated that a current of electricity had passed along the wires. This was the proof that life and electricity are one and the same thing.

There is no need to criticise the experimenter's method of investigation, although it is possible that the disturbances caused by his method are sufficient to account for the flow of electricity. There is no doubt that electric currents are often present when they are unsuspected. They are merely one method by which an uneven distribution of energy is equalized, and instead of being the cause of a certain state, they are most likely the effects of this state. Chemical changes are going on all the time everywhere, in the body and out of it, and these changes generally involve some redistribution of energy. The most common form, or at least the one generally recognized, is when a change produces heat. When conditions are suitable an electric current may flow; for example, if a piece of zinc and a piece of copper are plunged into sulphuric acid, a slight chemical reaction takes place at the zinc plate, but generally it does not last long. As soon, however, as two plates of metal are brought into contact

a violent reaction sets up, and it is found that an electric current passes between the two plates. We have here an active chemical reaction taking place whenever an electric current is allowed to flow and stopping as soon as the current is stopped, yet the current is an effect of the chemical reaction, and not the cause. May this not be true as well of the changes going on in the living body? Is it not more probable that any currents flowing through the body—and this has yet to be proved—are secondary reactions? The demonstration that a current may be drawn from a body by inserting foreign substances amounts to nothing. Under abnormal conditions abnormal effects take place. It seems very likely that our investigator has merely confused his cause and his effect—a confusion which is not at all unlikely to occur when one, however well versed he may be in one branch of science, attempts to explain facts by calling in another branch in which he is less learned.

THE OXYACETYLENE BLOWPIPE.

The use of acetylene in place of hydrogen for producing high temperatures seems not to have received the attention it deserves. There are claimed for this new heating flame some important advantages, one of them, at least, being of considerable practical value.

The oxyacetylene flame corresponds exactly to the old oxyhydrogen flame, except, of course, that acetylene is substituted for the hydrogen. Oxygen is generally obtained from a supply under pressure. For scientific purposes the value of this new heating flame will lie in the much higher temperature obtainable. It is said that under suitable conditions temperatures as high as 4,000 degrees centigrade may be reached—a temperature which is only surpassed by that given by the electric arc. Combined with this increase in temperature, it is claimed that it is as controllable as the oxyhydrogen flame, and can be used as a reducing or oxidizing agent, or simply as a neutral heating flame.

An advantage of this new flame, which will appeal to the workman, is the ease with which the necessary gases can be transported and generated. The acetylene is, of course, obtained from calcium carbide in any of the many types of generators. A high pressure is not needed, and while up to the present time the oxygen has usually been drawn from a supply compressed into a cylinder, there are to-day available a number of chemical agents which will yield this gas simply upon being treated with water. At the meeting of the American Electrochemical Society held at South Bethlehem, Pa., last September, Dr. Richard von Foregger called attention to some of these new products. One of them in particular, which has been given the trade name of "oxone," would seem to be very suitable for supplying the oxygen required. This material is merely the fused peroxide of sodium, and upon being brought into contact with water sets free oxygen gas instantaneously. Thus, with two small generators and a supply of oxone and carbide, one can construct a blow-torch capable of wide use, and giving exceedingly high temperatures. What the relative cost of this flame is, as compared with the oxyhydrogen flame, we can not say; but since the calorific value of acetylene is much greater than that of hydrogen, it would seem that the former flame should be cheaper. Added to these advantages is the safety of the apparatus. A high pressure is not necessary, as is true when gas must be stored under pressure, and with ordinary care there should be no danger.

THE UTILIZATION OF BLAST FURNACE GASES.

The scheme of utilizing the waste gases of blast furnaces is not at all new. It has time and again been the subject of discussion, yet, in this country at least, but little progress seems to have been made. This is true comparatively only, for the modern blast furnace utilizes to-day all of the gas for which it has any need for supplying the heat and power necessary to operate the furnace. That there is still a considerable amount of gas wasted is to be regretted, but this is merely because there is no call for the gas, and the companies which produce it have not yet been persuaded that it would be a good policy to use this by-product in producing energy in a saleable form.

That this blast furnace gas can be used effectively in gas engines driving electric generators is well known. This has been shown in practice as well as on paper; but it is not sufficient to demonstrate that the gas is a suitable fuel for a generating station. It must be shown first that electric power can be produced in this way cheaper than in a steam plant; and, moreover, the difference between the two must be sufficiently great to form a decided inducement to go into the undertaking. This phase of the question was considered in a paper read recently before the Western Society of Engineers by Mr. H. Freyn, an abstract of which appears in this issue of the ELECTRICAL REVIEW. Mr. Freyn shows that under the conditions which he assumes—and they seem to be fair—one horse-power-year can be delivered by gas engines operating on blast furnace gas for a little less than $18. This figure includes no charge for the gas, although it does include an item for cleaning the gas. Evidently, where other conditions are suitable, such a gas-driven generating plant should prove a paying investment.

However, the mere question of cost of production is not all. It is just as important that there should be a market for the output, and unless the company operating the furnaces has at the same time large shops and factories, or unless it has neighbors who can use the power thus developed, it would be hard to dispose of it. It is true that the power might be transmitted to a distant point for utilization there, but transmission is expensive and involves some difficult problems; and it seems to be expecting too much of the furnace company to ask it to jump at once into the electrical transmission of power. We hope that before long the increasing demand for electric power for all purposes will so change this situation for the better that this loss will no longer go on. At the present time it amounts to something in the neighborhood of one-half the gas given off by the furnace, and could be used to develop about 5,000 horse-power for each 400-ton furnace, according to Mr. Freyn's figures. The conditions in the coke-oven regions are somewhat the same, though they are rather exaggerated, for here practically all the gas is wasted and the market for power is smaller; but these losses now going on can not be charged to the discredit of the operating companies, and must be put down simply to the conditions at present prevailing.

THE ELECTRICAL NATURE OF MATTER AND RADIOACTIVITY.

BY HARRY C. JONES.

CHAPTER XV.—(*Concluded*).

CONTINUOUS FORMATION OF RADIOACTIVE MATTER IN THORIUM.

We have just seen that Sir William Crookes succeeded by a purely chemical means in separating from uranium a radioactive constituent, which was fundamentally different from uranium itself.

A similar separation has been effected by Rutherford and Soddy in the case of thorium. When a thorium salt is dissolved in water and the solution treated with ammonia, the thorium is precipitated. When the precipitate was tested it was found to be much less radioactive than the thorium salt. The solution from which the thorium had been precipitated was then evaporated to dryness, and ignited to remove salts of ammonium. The residue was found to be highly radioactive. Indeed, in some cases, many thousand times more radioactive than the thorium salt from which it was obtained.

The highly active residue was very small in quantity, and, therefore, must have contained some substance whose radioactivity was very intense. This product obtained from thorium was called by Rutherford *Thorium X*, and written *ThX*.

This substance was shown to be soluble in water, since when thorium oxide is shaken with water the radioactive constituent is partly dissolved, while thorium oxide itself is insoluble in water.

If a solution of a thorium salt is treated with ammonium carbonate, the thorium X is precipitated along with the thorium. The method of separating thorium X from thorium is, then, very different from that required to separate uranium X from uranium. We shall now study some of the properties of thorium X.

PROPERTIES OF THORIUM X—DECAY OF RADIOACTIVITY.

Thorium X, when separated from thorium by the method above described, is highly radioactive, as we have seen. Its radioactivity, however, decays, having only about half its initial value after four days. The decay becomes regular after a time, but at first irregularities appear. Indeed, the radioactivity of the thorium X at first actually increases. This peculiarity will be taken up later. After a short time the rate of decay is perfectly regular or follows an exponential law as we say.

The rate at which thorium X decays or loses its radioactivity, like uranium X, is uninfluenced by any known physical or chemical condition. Moisture, pressure and even temperature have no influence on the rate at which thorium X decays.

THORIUM X PRODUCES THE THORIUM EMANATION.

Both thorium and radium are capable of yielding that remarkable substance or substances already studied—the emanation. In the case of thorium does the emanation come from the thorium directly, or from thorium X? This has been answered by Rutherford and Soddy.

If thorium X is completely removed from thorium by repeated precipitations, the thorium has no appreciable power to give off the emanation. If, however, the thorium is allowed to stand for some time, it can give off an appreciable quantity of the emanation. This is due, as we shall learn, to the production of thorium X which is going on in the thorium itself.

The thorium X when first separated from the thorium has marked power to produce the thorium emanation. As the thorium X decays it has been shown that its power to produce the emanation becomes less, and indeed, in the same ratio. It will be remembered that the activity of thorium X falls to half-value in four days. Its emanating power falls to half-value also in four days. This shows that the thorium X is produced from the thorium emanation.

The changes that are going on in thorium can now be followed, at least in part. The thorium atom loses an alpha particle and the result is thorium X. The thorium X like thorium itself, is an unstable system and further changes take place in it. The thorium X loses one or more α particles, and the thorium emanation is the result. The radioactivity of the thorium emanation decays to half-value in about one minute, while the thorium X requires four days to lose half its radioactivity. The emanation is, then, a different substance from thorium X from which it was formed. This conclusion is confirmed by a comparison of all of the properties of these two substances.

Thorium X differs from uranium X in the kind of radiations given out by it. Thorium X gives out mainly α particles, while uranium X, as we have seen, gives out mainly β rays.

RECOVERY OF RADIOACTIVITY BY THORIUM.

We have become familiar with a method for separating thorium X from thorium. This method effects almost complete separation if the process is repeated a few times. If the thorium precipitated by ammonia is dissolved in nitric acid, and then again precipitated, and the process repeated twice, the resulting thoria is only about one one-hundredth as radioactive as ordinary thorium. The active thorium X has, thus, for the most part, been separated from the thorium.

If now this comparatively non-radioactive thorium is set aside, it regains its radioactivity again. A careful study of the rate at which thorium recovers its radioactivity, after thorium X has been removed from it, has been made by Rutherford and Soddy. They found that the thorium, in general, recovered its radioactivity *at the same rate* that the separated thorium X lost its radioactivity. Some irregularity manifested itself at first. Indeed, the activity of the thorium which had lost its thorium X *decreased*, instead of increased, for the first day or two. After this period, however, the thorium became gradually more radioactive, reaching half of its initial value in four days, which is the *same time* that was required by the thorium X to lose half of its radioactivity.

A careful comparison was made of the rate at which thorium X decays with time, and the rate at which thorium from which thorium X has been separated, recovers its radioactivity, and the results plotted in curves. It was found that *the one loses its radioactivity just as rapidly as the other regains its radioactivity.*

This can best be interpreted by assuming that *thorium X is continually being produced by the thorium.* The rate of production is just equal to the rate at which thorium X decays, and this gives us the condition of equilibrium that obtains in ordinary thorium.

It was found that thorium from which practically all thorium X had been separated, regained its initial radioactivity in just about *one month.* In a word, it required just about a month to establish the same condition of equilibrium that existed before the thorium was deprived of thorium X.

From the thorium which has regained its original radioactivity a new portion of thorium X can be separated, and exactly the *same amount* as measured by its radioactivity as was obtained originally. The non-radioactive thorium from which the second portion of thorium X had been separated, recovers its radioactivity again, at the same rate, reaching half-value in four days, and the initial value in one month. When the condition of equilibrium is reached again, a new portion of thorium X can be separated, which is

equal to that originally obtained, and thus the process goes on slowly but surely, apparently until all of the thorium is transformed into thorium X. This complete transformation would probably require millions of years.

RATE AT WHICH THORIUM RECOVERS RADIOACTIVITY INDEPENDENT OF CONDITIONS.

We would naturally ask whether transformations like those we have just been considering resemble ordinary chemical reactions, or are something fundamentally different from them? To throw any light on this question we must study the two sets of transformations, and see what resemblances or differences make their appearance. Chemical reactions are, in general, affected by the physical conditions of the substances that are reacting—by the state of aggregation, whether solid, liquid, gas, or in solution; by the pressure to which they are subjected, and especially by the temperature.

The rate at which thorium X is formed from thorium seems to be *entirely independent of all these conditions.* It does not seem to matter to what conditions we subject the thorium from which thorium X has been separated, we can not affect in any way the rate at which it recovers its lost radioactivity, which is the same as to say, the rate at which it produces thorium X.

There is, then, at least this one fundamental difference between the formation of thorium X from thorium, and ordinary chemical transformations—the former is independent of the conditions to which the substances are subjected.

A POSSIBLE EXPLANATION OF THE CHANGES THAT TAKE PLACE IN THORIUM.

We have considered most of the facts in connection with thorium, and the transformations that take place in it. Let us now see what they mean.

Thorium yields thorium X at a definite rate, that is unaffected by any change in conditions, and gives off α particles. Thorium X decomposes at the same rate at which it is formed in the thorium, and the rate of decay is unaffected by any change in conditions. It also gives off α particles. Thorium X in decomposing yields an emanation, and thus differs from uranium X, which does not produce any emanation.

It will be remembered that it is the emanation that gives rise to induced radioactivity in apparently all objects exposed to it, and undergoes further decomposition, yielding new radioactive products.

In the case of the emanation from thorium at least two products are formed. In the formation of the first product from emanation X no rays are given off. In the formation of the second product, α, β, and γ rays are all produced.

As Rutherford points out, and as has already been mentioned, these changes are not simply chemical reactions as we ordinarily understand that term, since they take place with a velocity that is entirely independent of the conditions that are brought to bear upon them. Rutherford suggests that these changes are not molecular, or even interatomic, but are *intraatomic,* or take place within the atom itself. Such changes would be expected to be independent of temperature, and of conditions in general.

We account for the transformations in the case of thorium in the following manner. The thorium atom, being unstable, loses an α particle, and the result is thorium X. The atoms of thorium X are, in turn, unstable. They lose an α particle and pass over into a new system which is the emanation.

The emanation then undergoes a change in which nothing is expelled. This is the first transformation of the emanation. It probably consists in a rearrangement of the constituents of the atom into a somewhat more stable system than that of the emanation itself. This system, however, is far from stable. A further transformation takes place either in a part of the emanation itself, or in the first product formed from the emanation, which is of a serious character. All three kinds of radiations, α, β and γ, are shot off, and the system then apparently settles down into one that is comparatively stable.

These transformations take place *very, very slowly.* Only a comparatively few thorium atoms become unstable at a time, and pass over into thorium X. We have seen that although thorium X decomposes comparatively slowly, requiring four days for half of it to decompose, it exists in thorium *only in very minute quantities.*

The subsequent transformations must, then, of necessity, take place only in very minute quantities of matter, since they are but successive decomposition products of the thorium X.

The *slowness* of the transformations that we have just been considering explains why such elements as thorium, uranium, and the like still exist, and have not all been transformed into their decomposition products. It is calculated that at least *thousands of years would be required for enough thorium to be transformed into thorium X, in order that the transformation would be detectable by the most sensitive chemical balance.*

THE CONDITION OF EQUILIBRIUM IN THORIUM.

The radioactivity of thorium, as we ordinarily know it, is constant, showing that there is an equilibrium between all of the above named processes. These are: the formation of thorium X from thorium; the transformation of thorium X into the emanation; the formation of emanation X or thorium A from the emanation, and the subsequent changes in emanation X, of which two are well-recognized. When equilibrium is reached, as in ordinary thorium, every one of these substances is being formed just as rapidly as it is undergoing decomposition.

We can now understand why it is that the radioactivity of thorium from which thorium X has been separated, *at first decreases,* and then increases regularly until the initial radioactivity is regained.

It will be remembered that thorium X is separated from thorium by precipitating the latter with ammonia. Since the thorium X is found in the solution it must be soluble in ammonia.

The emanation X, on the other hand, is not soluble in ammonia, and, therefore, is precipitated with the thoria. This emanation X, as Rutherford and Soddy show, decomposes comparatively rapidly, and this produces a decrease at first in the radioactivity of the thoria from which thorium X has been separated. It is true that this thoria is reforming thorium X, which increases its radioactivity. At first, however, this is insufficient to overcome the decrease in radioactivity due to the decay in emanation X, and the total result is a loss at first in the total radioactivity of the thoria. It will be remembered that after a short time the thoria regains its original radioactivity regularly, due to the continuous formation of thorium X.

We can now also understand why it is that the radioactivity of thorium X when just separated from thorium, *at first increases,* and then steadily decreases. The thorium X yields the emanation, which then quickly decomposes yielding emanation X or thorium A. The increase in radioactivity due to the emanation X more than compensates for the loss in radioactivity due to the decay of thorium X, and the result is at first a gain in radioactivity.

From a somewhat detailed study of the changes and processes going on in thorium and its decomposition products, we have

arrived at a rational explanation of the apparent irregularities in the decay curve of thorium X, and the recovery curve of thorium. These irregularities, which caused some trouble at first, have now been satisfactorily accounted for by Rutherford.

RADIUM DOES NOT GIVE RISE TO SUBSTANCES CORRESPONDING TO URANIUM X AND THORIUM X.

Radium has not thus far been shown to yield any substance analogous to those formed by uranium and thorium, which we have just been studying. It does not form any intermediate product, but apparently *yields the emanation at once.*

We have, however, followed the transformations of radium through a number of stages, the more important of which, it will be recalled, are the following:

1. Radium gives off α particles and yields the emanation.
2. The emanation gives off α particles and yields emanation X, or Radium A.
3. Radium A gives off α particles and yields radium B.
4. Radium B gives off no radiation and yields radium C.
5. Radium C gives off α, β and γ particles and yields radium D.
6. Radium D gives off no radiation and yields radium E.
7. Radium E gives off β and γ particles and yields radium F.

Meeting of the Executive Council of the National-Interstate Telephone Association.

A meeting of the executive council of the National-Interstate Telephone Association was held in Cleveland, Ohio, November 24, the following members being present: James B. Hoge, president, Cleveland, Ohio; Theodore Gary, first vice-president, Macon, Mo.; Colonel J. D. Powers, Louisville, Ky.; Ed. L. Barber, Wauseon, Ohio; Charles C. Deering, Boone, Iowa; George W. Beers, Fort Wayne, Ind. James G. Splane, treasurer of the association, was also present.

Reports were presented showing that associations have been formed and others were at present under way in a number of states which until this year were not interested in the matter of organization. The reports showed that franchises have been secured in a number of important cities, and that arrangements are being made to build long-distance lines in many localities. The various state organizations are in a healthy condition, and increasing in membership.

The following permanent committees were decided upon: "Standard Forms of Accounting," five members; "Standardization of Equipment," five members; "Standard Operating Rules and Regulations," three members.

AVAILABLE POWER AND COST OF OPERATION OF A POWER STATION FOR WASTE GASES FROM A BLAST FURNACE PLANT.[1]

BY H. FREYN.

The following calculation has been made assuming a new blast furnace plant of two 400-ton blast furnaces, situated in the immedate vicinity of a large city and having the ordinary facilities for water supply and for handling the raw and finished material. Assuming both furnaces in good operation and assuming a coke consumption of 1,900 pounds per ton of pig iron, there will be required $800 \times 1{,}900 = 1{,}520{,}000$ pounds of coke per day. This quantity of coke produces approximately 110,000,000 cubic feet of gas in twenty-four hours, or per ton of pig iron $110{,}000{,}000 \div 800 = 137{,}000$ cubic feet of gas. The losses on the top of the furnaces may amount to approximately five per cent, so that 130,000 cubic feet of gas per ton of pig iron produced in twenty-four hours could be obtained. The average heat value of this blast furnace gas will be about ninety British thermal units per cubic foot. The total quantity of gas available for the various purposes in this blast furnace plant amounts to $130{,}000 \times 800 = 104{,}000{,}000$ cubic feet of gas per twenty-four hours or 4,350,000 cubic feet per hour, having a total heat value of 391,500,000 British thermal units. Modern double-acting gas engines of large capacity working on the four-cycle or Otto principle, built with the latest improvements and using high compression of mixture, consume less than 9,000 British thermal units per brake-horse-power per hour at full load capacity. The total quantity of gas produced by two blast furnaces of 400 tons capacity each, when used in gas engines for generating power, would operate at least $391{,}500{,}000 \div 9{,}000 = 43{,}500$ horse-power per hour. If, therefore, all the gas generated by a blast furnace plant could be used for producing power, there would be available over fifty horse-power per ton of pig iron produced per twenty-four hours.

This quantity of 4,350,000 cubic feet of gas per hour will be divided for the various purposes of the blast furnace plant as follows: one part of the gas is used for heating hot-blast stoves, another for operating gas-blowing engines and there is gas required for the auxiliary machinery, such as pumps, hoists, coke and ore-handling machinery, power transmission, compressed air, pig-iron casting machinery, and for lighting the entire blast furnace plant; some of the gas is also necessary for operating gas engines, serving the gas-cleaning plants and a certain percentage may be counted for losses in the piping, in the engines, the gas-cleaning plant, etc. It will be seen that the total quantity of gas necessary for the operation of the blast furnace plant itself amounts to approximately fifty per cent of the total quantity generated, leaving a little less than fifty per cent available for useful work outside of the blast furnace plant itself.

The blast furnaces are subject to certain unavoidable irregularities on account of which a "coefficient of safety" must be introduced in the calculation for determining the available power from a blast furnace of a given capacity. This coefficient is of course extremely variable and depends largely upon the pig-iron market (which might require a banking of the furnaces), upon the operation of the furnaces, the quality and supply of ore, coke, etc. It is very difficult to foretell how much of the total theoretical available horse-power from two 400-ton furnaces could actually be realized especially when the electric power generated by using this gas in gas engines is to be sold to outside consumers to whom the delivery of a certain amount of power naturally must be guaranteed, perhaps under a heavy penalty. This irregularity in the operation of a blast furnace will have a very great influence on the production of gas, affecting the quantity as well as the quality.

With two blast furnaces only it would be perfectly safe to figure on the available horse-power from the gas of one furnace only, assuming this coefficient to be 0.5.

A blast furnace plant of only two 400-ton furnaces should be equipped in the beginning with a power station of only limited capacity corresponding to the available power from only one furnace, installing later on additional units, if the conditions and operations of the furnace plant would be such as to safely permit the generation of additional electrical power.

The following calculation has been made on the assumption that an electric power plant of about 10,000 brake-horse-power be installed first. The size of unit best suited for this power plant would be an engine of about 1,500-brake-horse-power capacity. Seven gas engines of 1,500-brake-horse-power rated capacity would develop 10,500 brake-horse-power.

In order to meet emergencies, an eighth

[1] Abstract of paper read before the Western Society of Engineers, December 20.

engine as a standby or spare unit should be installed, so that the power plant in the beginning would consist of eight units as above.

Generators of 800 kilowatts would, at the rated load of the gas engines of 1,500 brake-horse-power, develop about 1,000 kilowatts or 800 kilowatts plus twenty-five per cent overload. At maximum load of the gas engines of 1,650 brake-horse-power, the generators would carry 1,120 kilowatts each, or 800 kilowatts plus forty per cent overload.

It will be seen that 800-kilowatt generators would perfectly fulfil the requirements, as they easily stand an overload of twenty-five per cent for twenty-four hours and an overload of forty per cent for short periods.

COST OF ELECTRIC POWER STATION OF 10,000-BRAKE-HORSE-POWER CAPACITY.

The complete equipment of the power plant would consist of eight double-acting gas engines with a rated load of 1,750 indicated-horse-power, or 1,500 brake-horse-power each, to be direct-connected to an alternating-current, 800-kilowatt, three-phase, twenty-five-cycle, 6,600-volt generator.

The total cost of this station would be about $741,000. Of this, that portion of the gas-cleaning plant chargeable to the power station would be $33,500. The building for the electrical equipment would cost about $45,000, the gas engines $424,000, and the complete electrical equipment, including dynamos, exciters, switchboard apparatus and all accessories, would cost $162,500. The remainder would be made up by the buildings, gas-cleaning plant, foundations, piping, a traveling crane, etc.

The cost of this installation per brake-horse-power, estimating a total output of 12,000 horse-power, would be $61.60. This is equivalent to a cost per kilowatt of $89.50, the total output in kilowatts being 83,000.

OPERATING COST OF POWER PLANT.

The operating cost of the plant consists of the following items: fixed charges, cost of water for washing gas and cooling engines, oil and grease, repairs, wages and fuel. The fixed charges are estimated at an average of thirteen and one-half per cent on the total cost of the plant, which brings this item per year to $100,000. This includes interest at five per cent, depreciation at figures varying from ten per cent for the gas-cleaning plant to four per cent for the buildings, and insurance at one per cent. From this the fixed charge per kilowatt-hour at full load amounts to 0.1575 cent; at three-quarter load the fixed charge is 0.2076 cent; and at one-half load it is 0.1371 cent. The cost of water for cleaning the gas and cooling engines is estimated at 0.02874 cent per kilowatt-hour at full load; at half load it will be 0.03514 cent per kilowatt-hour; and at quarter load, 0.04236 cent. The cost of oil and grease would be 0.0246 cent, 0.02922 cent and 0.04219 cent per kilowatt-hour at full load, three-quarter load and half load, respectively. The corresponding figures per kilowatt-hour for repairs would be 0.02834 cent, 0.03362 cent and 0.04852 cent. The operating staff consists of a chief engineer, an assistant engineer, and twenty-nine machinists, helpers, dynamo tenders, clerks, etc. The salaries for these will amount to $35,346 per year, corresponding to 0.05566 cent per kilowatt-hour at full load, and 0.06953 cent and 01.1002 cent per kilowatt-hour at three-quarter and half load, respectively.

It is generally assumed that the cost of the fuel for such a plant would be nothing, but the author agrees with Mr. L. Ehrhardt-Schleifmuehle that it is only proper to charge a plant with the value of the fuel which it uses. This may be estimated either by comparing the heat value of the gas with that of coal, or by comparing it in a similar way with natural gas. Both ways are carried out here, and the value of the gas is estimated to be one cent per thousand cubic feet. This would bring the fuel cost per kilowatt-hour at full load, three-quarter load and half load, respectively, to 0.1448 cent, 0.1629 cent and 0.1944 cent.

Summing up the above estimates, it is seen that a power plant of about 10,500 brake-horse-power, complete in every detail, and installed in connection with a blast furnace plant, should be capable, when running under full load, of producing one brake-horse-power per year at the low cost of $17.88, no value being placed on the blast furnace gas.

From the above estimates it is also found that at full load output the cost of one brake-horse-power would be 1.295 mills. When the average output of the plant is only one-half of its total rating, the cost of one kilowatt-hour will be 5.5 mills.

The author then compares these figures with those actually obtained in the large works of the John Cockerill Company, in Belgium. This company is operating seven blast furnaces, large steel plants, rolling mills, machine shops, turbine works, locomotive works, etc. It has greatly extended the use of electric power for all purposes during the past five years. In 1900 the company had but eighty-six motors in use, while during 1905 it was using 333 motors. The lighting outfit consists of 660 arc lamps and 5,600 incandescent lamps. The company installed a steam plant in 1900, but has since been reducing this and installing gas engines. At the present time the total rating of the plant is 3,700 kilowatts. During the year 1900, when the rating of the plant was only 1,000 kilowatts, the operating cost was over 200,000 francs. During last year, when the plant had been increased 370 per cent, the total operating cost increased only thirty-one per cent. The cost per kilowatt-hour in 1900 was 1.66 cents, while in 1905 it was only 0.412 cent. Although it is admitted that the cost per kilowatt-hour would have decreased with an increase in the steam plant, the records show that the decrease obtained was due almost exclusively to the installation of gas engines. These figures are not entirely applicable to American conditions, but they demonstrate the benefit to be derived from the utilization of blast furnace gases.

The Chicago Electrical Show.

It is announced that the various telephone interests throughout the country have taken a very keen interest in the coming electrical show to be held in the Coliseum, Chicago, Ill., from January 15 to January 27. Several novelties in the way of telephone development will be exhibited, and January 22, 23 and 24 have been set aside as telephone days. The Chicago Telephone Company will make an interesting exhibit.

During the exposition there will be three conventions at the Coliseum: the Northwestern Electrical Association, the Electrical Salesmen's Association, and the Credit Men's Association of the Electrical Trades.

On Wednesday, January 17, Ben Franklin day will be celebrated. This is the two hundredth anniversary of Franklin's birth.

The annual convention of the Northwestern Electrical Association will be held January 17 and 18.

The complete list of exhibitors is as follows: Ackerman-Boland Telephone Company, Allis-Chalmers Company, American Circular Loom Company, American Conduit Company, American De Forest Wireless Telegraph Company, American Electric Company, American Electric Fuse Company, American Novelty Company, American Steel and Wire Company,

American Electric Sign Company, *American Telephone Journal,* Automatic Telephone Electric Company, Bryan-Marsh Company, Central Electric Company, Chicago Battery Company, H. B. Camp Company, Chicago Compound Battery Company, Chicago Edison Company, Chicago Pneumatic Tool Company, Chicago Telephone Company, Frank B. Cook, Crane Company, Crocker-Wheeler Company, W. P. Crockett & Company, W. L. Freed Company, Electric Appliance Company, Electrocraft Publishing Company, Electro-Dynamic Company, J. Lang Electric Company, S. J. Gorman & Company, Guarantee Electric Company, Edwards Headlight Company, *Engineering World,* Electric Storage Battery Company, Federal Electric Company, Fort Wayne Electric Works, North Shore Electric Company, General Storage Battery Company, D. Holcombe & Company, Safety Armorite Conduit Company, W. H. Schott, W. Schiedel Company, Simplex Electric Company, Stanley-G. I. Electric Manufacturing Company, G. H. Thordarson, Engineer Publishing Company, Universal Electric Storage Battery Company, Vesta Accumulator Company, Western Electric Company, Wagner Electric Manufacturing Company, Westinghouse Electric and Manufacturing Company, *Western Electrician,* General Electric Company, Haller Machine Company, H. T. Paiste Company, Krantz Manufacturing Company, Lincoln Electric Manufacturing Company, Monarch Electric and Wire Company, Miller Anchor Company, Mark Manufacturing Company, McFell Electric Company, Nungesser Electric Battery Company, Oliver Manufacturing Company, Overbaugh & Ayers Manufacturing Company, Osburn Flexible Conduit Company, Peabody Coal Company, Peru Electric Manufacturing Company, Porterberg-Peterson Manufacturing Company, John A. Roebling's Sons Company, Roth Brothers, Reynolds-Dull Flasher Company, J. L. Schureman & Company, Stromberg-Carlson Telephone Manufacturing Company, Swedish-American Telephone Company.

The Seventh Annual Dinner of the Olympic Club.

The seventh annual dinner of the Olympic Club, the membership of which includes quite a number of prominent electrical men, was held at Shanley's, Broadway and Forty-second street, New York city, on the evening of December 18, 1905. There were an elaborate menu, and a very enjoyable vaudeville entertainment. Mr. James Kempster presided.

ELECTRICAL MINING NOTES.

BY SYDNEY F. WALKER.

SECONDARY ELECTRICAL HAULAGE.

Electricity is being more and more adopted for what is called secondary haulage in coal mines. Up till very recently horses, and occasionally donkeys, performed this work, but it has been shown that mechanical haulage is always cheaper than animal, and with the gradual conversion to electrically driven collieries that is going on all over Great Britain, the adoption of electric motors for secondary haulage is just in the natural order of things. Two very striking instances have recently come under notice. It will be remembered that by secondary haulage is meant the haulage which feeds the main haulage ropes. In all collieries there are one or more main haulage roads, generally worked by endless ropes, to which the mine wagons are attached at intervals, one part of the rope constantly bringing loaded wagons to the shaft bottom and the other as constantly taking the empty wagons that are delivered at the shaft bottom from the surface into the working faces. The secondary haulage brings the loaded wagons from the working faces to the main haulage, and takes the empty wagons from the main haulage to the working faces. The plan with animal haulage has been for the horse to draw each wagon out to the main road as it is filled, and to bring back the empty wagon when it arrives. In one of the two cases referred to above, several working places are on one face, "longwall," as it is called, extending for some distance, and opening to the main haulage road at one end. Along the coal face an endless rope is stretched from an electric motor at the main road end to a tightening pulley at the other end, the motor driving it by the usual friction pulley, a pulley of comparatively large diameter, wide enough to take three turns of the wire rope. The loaded wagons are attached to the rope as they are filled, and hauled out to the main road, where they are attached to the main haulage rope, the empty wagons which arrive opposite the coal face road being detached from the main haulage rope and attached to the face haulage rope. The other arrangement is a modification of the main and tail haulage system, especially adapted for "pillar" and "stall" working. It should be of interest in America, as that is the system of working very largely in use in American coal mines. "Pillar" and "stall" working is also called "bord" and "pillar," and the American method is a modification of it. There are a number of stalls or working places extending along the coal face that are being worked. The stalls are separated by ribs of coal, the stalls ranging from eight feet to sixty yards in width, the wider stalls being common in America, and the narrower usual in Great Britain. A road extends along the face at the back or shaft side of each stall, and along this road a main and tail rope works. In main and tail haulage, it will be remembered, there are two ropes, called respectively the main rope and the tail rope. The main rope is connected to the front of the train of wagons, which it pulls out to the haulage drums, while the tail rope is carried round a pulley at the end of the road and is attached to the end wagon of the train. The main rope is wound up on one of two drums, while the tail rope is allowed to run out on the other. Then, after the full wagons have been hauled out, the empty wagons take their place, the tail rope being wound up on its drum and the main rope allowed to run out, the wagons being hauled back to the face. In the arrangement referred to above the tail rope is divided into two, the second portion being carried round a sheave in each stall. There are as many of these second portions of the tail rope as there are stalls. When no wagons are being hauled out of or into any particular stall the idle rope, as it is called, lies in the stall with both ends near the road passing at the back of all the stalls. When empty wagons are to be carried into any stall they are connected between one part of the tail rope and the idle rope, the other end of the idle rope being attached to the end of the tail rope. The empty wagons having been pulled into the stall, the full wagons that take their place are pulled out to the road at the back and are there connected into the main and tail system running along that road, the idle rope being disconnected and left with its two ends ready to connect again when required. The arrangement is stated to work very well, the drums on which the ropes are coiled being driven by an electric motor, and it is the great convenience of the electric motor, and the efficiency of transmission that enables it to be accomplished. It is claimed that these arrangements, the endless rope passing along the face, and the main and tail feeding "pillar" and "stall," are superior to the conveyer system, because they avoid the necessity of

handling the coal a second time between the face and the screens.

A MODERN COLLIERY POWER STATION.

The Powell Duffryn Company is one of the largest coal owners in the United Kingdom. It has two groups of collieries, one in the valley of the Cynon and its tributary the Aman, in Glamorganshire, and the other in the valley of the Rhymney in Monmouthshire. The collieries in the Cynon and Aman valley are placed at intervals on the sides of the hills bounding both of the valleys, and the power station is placed near the junction of the two valleys and close to the main line of the Taff Vale Railway, which supplies the district, the distance to the farthest colliery of this group, Forchaman, being two and one-quarter miles. The power consists of three units, one of 2,000 kilovolt-amperes, and two of 1,000 kilovolt-amperes. The reason for this arrangement is the work was commenced with two units of 1,000 kilovolt-amperes, it being intended to have a third as spare, but it was discovered later on that more power would be required than had been provided for and so the last unit was made 2,000 kilovolt-amperes. The light load is only at present about 600 kilovolt-amperes, but on test it has been shown that the larger machine works with a lower steam consumption with that load than the smaller ones under the same conditions. The generators are flywheel alternators, made by the Allgemeine Gesellschaft, of Berlin, represented in Great Britain by the Electrical Company of Charing Cross road, London, and they are driven by horizontal, cross-compound engines, with Corliss valves, made by Yates & Thom, of Blackburn, Lancashire. The dynamos generate three-phase current at 3,000 volts, and the exciter dynamos are driven by ropes from pulleys on the engine shafts. Babcock boilers are used at present hand-fired, but probably mechanical stokers will be employed later. The problem at a colliery power station is what to burn. There are two classes of fuel that are available, because they can not be sold, the very fine dust that is taken from the settling-ponds, into which the water used in washing is delivered, and the substances lying on the outside of the different seams, which contain a certain amount of carbon and other combustible matter, but not sufficient to tempt the average works owner. It is not quite easy to deal with this where mechanical stokers are employed. At present ordinary small coal is used at the Powell Duffryn Company's stations and each boiler furnace has to be cleaned out every shift, half being cleaned out at a time. This must lead to the entry of a large quantity of cold air and to the cooling of the furnace very considerably. Apparatus is being erected for delivering the fine dust from the washing machine by means of a conveyer into bunkers over the boilers, from which it can be fed to the stoke-hole floor or the mechanical stoker hoppers, as may be arranged. The Powell Duffryn Company is making another interesting experiment in the using of refuse. It is putting up a gas producer, which is to burn the refuse, the gas from which is to be used to fire the boilers supplying steam for a pair of large pumping engines.

Condensers are employed at the power station, a vacuum of twenty-six inches being obtained. They are of the jet type, the water from the adjacent river being employed, and it not being necessary to pump. The condensers are fixed directly under the engines. The steam consumption is given as twenty-three pounds per kilowatt-hour with the 1,000-kilovolt-ampere sets, and twenty pounds with the 2,000-kilovolt-ampere set. The steam is superheated 120 degrees Fahrenheit, and the feed water is heated 150 degrees by a Green economizer of 800 tubes.

The cost of generation is given at 0.16 penny per unit, omitting depreciation and interest, which will come to 0.15 penny when the plant is fully utilized, making 0.31 penny per unit. At this figure it appears to me that it would be difficult for the South Wales Power Company to supply at a lower price, seeing that it has to distribute as well as to generate. There are seventy-six motors, aggregating 4,650 horse-power, connected to the service, those over fifty horse-power having the full 3,000 volts taken directly to the stator, while for motors below fifty horse-power the current is transformed down to 500 volts. The motors have been in nearly every case adapted to the existing apparatus, haulage gears, etc. In one of the collieries, also, there was already a small power and lighting station, worked by continuous current at 220 volts, there being two dynamos driven by belts from a single engine. In this case the engine has been replaced by a three-phase motor taking current from the 3,000-volt service, its axle being directly connected to the axles of the continuous-current generators, the motors and lights already in service being left as they were. The arrangement works very well. There are substations in different parts, and in particular one at one of the pit bottoms to which the 3,000-volt cables are brought. In the substations at the pit bottom each set of switches is enclosed in a brick cell, the front of which is closed by an iron door. In the first cell are the safety apparatus, and the current then passes to the bus-bars, extending along the back of all the cells. One of the other cells is devoted to each important branch of distribution, and two cells are arranged to connect the bus-bars with the transformers: one for the 500-volt service for the motors, and one for the lighting service, which in this case is at 110 volts. There are a small winding plant and several main and tail haulage plants worked directly from the 3,000-volt service. In the engine room, in each case, are a circuit-breaker for overload with switch combined and an emergency hand switch, both enclosed within a wire cage. From these the cables pass to the controller, which is in two parts, though worked by one handle. The driver, in turning his wheel, throws in or takes out resistance in the rotor circuit of the motor in starting and also changes the connections of the stator circuit. The controller also carries a connection operating the electromagnet which frees the brake. There is a brake pulley on one of the axles of the gearing, something on the same line as is used with electric lifts, fitted with a band brake, which is lifted off, when the apparatus is in use, by an electromagnet. At the first notch of the controller the brake is lifted off and the full resistance is inserted in the rotor circuit, the connections of the stator circuit being arranged at the same time for the direction in which the motor is to run. As the wheel is turned the resistance is gradually taken out, there being provision for eight different speeds. Reversal is obtained by turning back the wheel, and in so doing altering the connections of two of the three phases with regard to the third. The cables for general distribution are naked copper, carried on triple petticoat insulators overhead. For the pit, shafts and similar positions, paper three-cored cable is used, the section of the conductors being a sector of a circle, the completed cable being overlaid with lead as usual, with a copper sheath under the lead and steel wire armor outside, the copper sheath being earthed. A bare copper wire is also provided for earthing.

American Association for the Advancement of Science.

The New Orleans meeting of the American Association for the Advancement of Science and the affiliated societies began on December 29, when Professor W. G. Farlow, of Harvard University, delivered the presidential address, his subject being "The Popular Conception of the Scientific Man at the Present Day."

Swiss Electrolytic Plants.

By C. L. Durand.

A CONSIDERABLE number of electrometallurgical and other electrolytic plants are now in operation in Switzerland, where a convenient supply of water power is to be had for the purpose. Among the products which are turned out by these works may be mentioned aluminum, chrome iron and steel, besides different chemical products such as chlorate of potash, chlorine and soda.

In the La Praz works, which are under the control of a French company, the Société Electro-Métallurgique, the current is used, for the most part, in the production of aluminum, according to the Héroult method. But aluminum is not the only product which is furnished by the establishment, and it is now devoting considerable attention to the manufacture of chrome iron, which is used to a great extent in Europe at present. Steel is also turned out by a new process, in which the electric furnace is used, and the manufacture of steel on a commercial scale, which is now only commencing, is likely to take considerable proportions in the future. As most of these processes are patented, only a description of the central station which furnishes the low-tension current for the different electrolytic purposes is given.

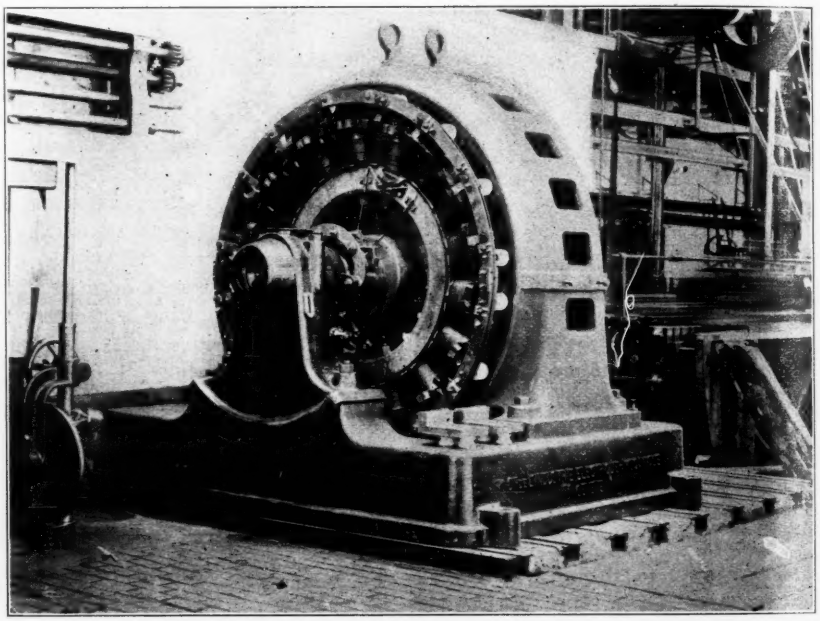
The La Praz works are situated in one of the most mountainous parts of the Savoy region, not more than two miles from the Italian frontier, in the valley of the Arc. The electric station and the different factory buildings cover a considerable extent of ground. The Mount Cenis railroad runs near the premises. The hydraulic power which is needed for the electric plant is furnished by the Arc, a rapid mountain stream which descends from the heights of the Haute Maurienne. It has a greatly varying flow, in the proportions of one to sixty at least. The hydraulic work was carried out in two stages. The first one of these, in which a dam was built about half a mile above the station, afforded a head of water of 105 feet. An open canal brought the water to the main basin, from which led a penstock of five feet diameter. During the second stage of the hydraulic work a second dam was erected across the river one and one-half miles above the station, in order to secure a new fall of 240 feet. A masonry tunnel brings the water to the settling basin. From there a penstock, eight feet in diameter and 2,800 feet long, furnished by the Bietrix-Nicollet Company, of St. Etienne, brings the water down to the turbine station.

The total hydraulic power which can be utilized in the present plant is estimated at 14,000 horse-power. The direct-current generators which have been installed in the station will furnish a total of 8,000 horse-power, and this amount is to be further increased in the future. The La Praz station has been increased and modified at different periods, and thus we find various types of electrolytic generators set up in the dynamo room. The whole of the electric outfit, however, has been furnished by a single firm, the Compagnie de L'Industrie Electrique, of Geneva, and the machines are built on the Thury system. When the plant was first started, the company was called upon to furnish a set of machines of very low voltage and heavy current, giving some 350 horse-power each. These generators are direct-coupled to turbines, which are built by the firm of Brenier-Neyret, of Grenoble, France. Three other machines of the Thury type, varying from fifty to 250 horse-power, were installed along with the others for supplying the lighting circuit of the factory and the different motors. At a later period, as the demand for current increased, another set of generators was set up. These are six-pole Thury machines, which give a current of 100 volts and 3,000 amperes in ordinary running, and work at a speed of 250 revolutions per minute. The second set of machines are disposed in two series, each composed of three machines connected in parallel, and a generator which acts as a reserve.

As the seven machines above mentioned gave very good results for the electrolytic work, it was decided to erect another series of fourteen machines of the same type.

More recently the company decided to take up the manufacture of steel by its newly patented electric furnace process. In this case the electric furnace is designed to use alternating current at about 100 volts. The first alternator which was designed by the Thury company on this system is shown in one of the engravings. It is intended to operate at 250 revolutions per minute and 33.3 cycles, and will furnish 110 volts at a heavy current of 4,000 amperes on an inductive circuit with a power-factor of 0.8. The field-bore is 1.5 metres and the length of the pole-pieces 500 millimetres. It has a five-millimetre air-gap. The shaft of the machine carries the turbine wheel, which is mounted upon it, without using an outer bearing. The total height of the alternator is 2.275 metres, and the greatest width 2.6 metres.

The machine has a fixed armature ring,



THE NEW THURY 4,000-AMPERE ALTERNATOR INSTALLED AT THE LA PRAZ ELECTROLYTIC WORKS.

which is carried within the main casting, and inside the armature is the revolving field, formed of a set of poles mounted on the main drum. The armature ring, which is 150 millimetres in thickness, is formed of laminated iron, in four separate parts, leaving a set of openings between them for ventilation. The armature winding is composed of sixteen parallel circuits. All the circuits of the armature are brought to two large copper rings, which are mounted on insulators upon this way they can be readily taken out when it is desired to replace them.

As to the internal field of the alternators, it is formed of sixteen poles of laminated iron. The poles are fixed on a cast-iron cylinder by means of heavy bolts. Each of the poles carries a winding of a square section copper wire, measuring 6.5 millimetres on a side. The fields are excited by a current of 120 volts, or they may be connected so as to use a sixty-five-volt current. A collector ring, which

Monthey, which lie on the east of lake Leman, and also the electrolytic plant of La Volta, situated on the Rhone not far from Geneva. Several large Swiss plants are engaged in the manufacture of chlorate of potash by a series of patented electrolytic processes. Among these the most prominent are the Cheddes plant, on the Arve river, and the St. Michel works, which, like the La Praz plant mentioned above, use the power of the river Arc.

THE THURY DYNAMOS AT THE CHEDDES ELECTROLYTIC WORKS.

the body of the machine. Each of the armature coils is made up of a copper band, having a section of forty-two by 2.2 millimetres, and well insulated. The windings are placed in slots measuring fifty-three millimetres deep and thirty-five millimetres in width.

The winding of each of the coils is carried out so as to divide the ends into three groups, which are well separated, so that the extremities are well cooled. The coils are held in place by a series of wood strips, which are run into dove-tailed grooves in the top of each slot. In is mounted upon the shaft of the machine, allows the current to be taken into the field coils.

A number of hydroelectric plants in Switzerland, besides the one just mentioned, have been erected for the purpose of supplying current to electrolytic works which are engaged in the manufacture of various products. Among these are to be noted the plants which use electrolysis of the natural chlorides for producing chlorine and caustic soda along with other substances. In this category are included the large works of

The accompanying engraving shows a view of the interior of the Cheddes station which lies alongside the electrolytic factory and furnishes the current required in the chlorate of potash manufacture. The Cheddes plant is situated in the Haute Savoie region, at the entrance of the Chamonix valley. Power is obtained from the Arve, a mountain torrent which descends from Mont Blanc. The total length of the water canal which leads from the dam is 1.1 miles. From the main basin a set of penstocks, four and one-half feet in diameter, leads down

to the turbine station. The turbine wheels which are mounted in the Cheddes plant are of the horizontal shaft pattern, and the turbine house lies alongside the main dynamo room, which is represented in the engraving. The shafts of the wheels pass through the partition wall, and are connected direct with the generators by means of elastic couplings.

In the foreground the details of the large generators which have been mounted in the Cheddes plant will be clearly observed. These machines, which have been also furnished by the Compagnie de L'Industrie Electrique, of Geneva, are of the Thury eight-pole type, and are of the consequent pole construction which has been generally adopted by M. Réné Thury. A current of 800 amperes at 700 volts is furnished by the generators, or 560 kilowatts each. The turbines have been supplied by a French company, the Brenier-Neyret firm, of Grenoble.

Annual Meeting of the Independent Telephone Association of Wisconsin.

The annual meeting of the Independent Telephone Association of Wisconsin was called to order at the clubroom of the Hotel Pfister, Milwaukee, Wis., Wednesday, December 20, 1905, at 12.45 P. M., President Richard Valentine in the chair. The president opened the convention by referring to the question of membership, and, on motion, a committee was appointed, consisting of J. C. Harper, W. F. Goodrich and Messrs. Webb, Wilder and Bates, to handle this question. This committee was also directed to prepare resolutions for presentation to the Milwaukee common council regarding the matter of granting an independent franchise in the city of Milwaukee. After considerable discussion as to ways and means of gaining the most strength and making the matter of specific interest to the city officials of Milwaukee, a recess was taken to meet at two o'clock at the same place.

On Wednesday afternoon at 2.30 o'clock President Valentine called the convention to order. An adjournment was immediately taken to the place of meeting of the judiciary committee of the common council at the city hall in the city of Milwaukee. At three o'clock the association met in the presence of the council committee. Mr. Valentine, representing the association, addressed the committee on the subject of a measured service *versus* a flat-rate system of charging. Arguments were also presented by Don J. Farnsworth, Max Zabel and Messrs. Wills, Stroud and Hoffman. The judiciary committee at this session was unable to reach an immediate agreement, and adjourned, the chairman stating that the next meeting would be called in about two weeks, when the various franchises offered would be considered. The association thereupon adjourned to meet the next day at the Hotel Pfister.

On Thursday, December 21, 10.30 A. M., the third session was called to order by President Valentine. Mr. Harper presented the resolution pertaining to the membership of the association for the committee appointed on Wednesday.

After some discussion a motion was made and unanimously carried, that this committee draft a resolution urging the common council of the city of Milwaukee to grant an independent telephone franchise in the city as speedily as possible.

The nominating committee was then appointed, as follows: W. J. Bell, Deerfield; Dr. G. N. Hidershide, Arcadia, and Charles Shernecker, Sun Prairie.

A very lengthy discussion was held concerning the status of various telephone companies in the state of Wisconsin, following which Mr. J. S. Eaton, of New York, representing the Poulsen automatic telegraphone, was introduced. Mr. Eaton described briefly the characteristics of this apparatus. A discussion followed Mr. Eaton's remarks, and then the report of the secretary was called for.

The secretary reported that the association was organized at Weyauwega, March 21, 1900, with eighteen members. Since that time the membership has grown to sixteen active and twenty-nine associate members, comprising approximately three-fourths of the independent telephone organizations in the state. Forty-one new companies were incorporated in 1902, forty-nine in 1903, thirty-two in 1904, and thirty-nine in 1905, with a capital of $415,000. A careful estimate, based on the best data obtainable, gives Wisconsin 300 independent telephone companies, with an investment of $4,000,000, 1,300 toll stations, 375 exchanges, and 42,000 subscribers.

After some discussion a motion was carried that the assessment for the coming year be placed at two cents per telephone, and two cents per mile of toll line.

The names of two new applicants for membership—the Chippewa County Telephone Company, and the Deerfield Telephone Company—were presented, and these companies were elected to membership.

Mr. Bell then presented the report of the committee on nominations, as follows: for president, Richard Valentine, Janesville; for vice-president, J. C. Kuoni, Sauk City; for secretary and treasurer, W. F. Goodrich, La Crosse. Executive committee—William Van Middlesville, Racine; Phillip Sheridan, Green Bay; J. C. Harper, Madison; E. I. Bates, Chippewa Falls; John M. Baer, Appleton; W. J. Bell, Deerfield; J. C. Crowley, West Superior. The report of the committee was unanimously adopted, and the nominees therein named were declared duly elected.

Following the election of officers there were a few brief comments made by Messrs. Bell, Goodrich and Dinsmore. The subject of the Electrical Trades' Exposition at Chicago was discussed, Mr. Dinsmore inviting the association to attend the electrical show.

The following exhibitors and representatives were in evidence:

Julius Andrae & Sons Company, Milwaukee; J. C. Schmidtbauer and H. P. Andrae.

Frank B. Cook, Chicago; F. W. Pardee, P. M. Chamberlin and R. E. MacDuff.

Kellogg Switchboard and Supply Company, Chicago; Frank Rotchka.

Vought-Berger Company, La Crosse, Wis.; P. W. Goodman.

American Electric Telephone Company, Chicago; M. W. Zabel, J. C. Henderson.

Illinois Electric Company, Chicago; E. A. Quarfot, N. G. Harvey.

Standard Telephone and Electric Company, Milwaukee; H. M. Eldred, H. C. Biester.

Stromberg-Carlson Telephone Manufacturing Company, Chicago; J. J. Nate.

Milwaukee Telephone Manufacturing Company, Milwaukee; F. J. Wittemore, A. Gieger.

Independent Telephone Manufacturing Company, Madison; A. L. Burch, Frank Quinn.

Armour Institute, Chicago; Dr. G. W. Wilder.

Sterling Electric Company, Lafayette, Ind.; H. T. Doolittle.

Monarch Telephone Manufacturing Company, Chicago; L. Q. Trumbull, A. Duncombe.

Electric Appliance Company, Chicago; S. A. Dinsmore, J. B. McMullen.

Miller Anchor Company, Chicago; G. H. Miller.

North Electric Company, Cleveland, Ohio; I. J. Kusel.

J. A. Roebling's Sons Company, Chicago; A. Wissler.

Automatic Electric Company, Chicago; C. L. Fisher.

Standard Underground Cable Company, Chicago; Mr. O'Neill.

SOME CONSIDERATIONS DETERMINING THE LOCATION OF ELECTRIC RAILWAY SUBSTATIONS.[1]

BY C. W. RICKER.

No attempt will be made in this paper to define the conditions under which indirect distribution through the medium of transformer substations, is more economical than direct distribution from one or more generating stations containing prime movers. It is assumed that because of the size of the railways to be considered, and the local conditions determining the cost of generating power, the indirect method of distribution has been selected as offering the best economy in commercial operation, and an attempt will be made to outline a general method for determining the number and location of substations.

In many cases, perhaps the majority of cases, a general solution of this problem is quite impossible. Most of the large electric railway systems now in existence are the result of development not foreseen by their original projectors, and there is little reason to believe that future systems will be very widely different in this respect, but probably they will continue to grow by extensions and consolidations depending upon the distribution and development of local centres of industry and population.

For convenience of discussion, electric railways large enough to require indirect distribution may be classified as follows:

1. Large simple networks, serving a single community.

2. Long single lines or groups of such lines, connecting separate communities or different parts of a very large one.

3. Complex networks, with connecting lines, serving a city and its suburbs.

4. Several networks with long connecting lines, serving separated communities.

Railways of the last-named class are usually consolidations of the local systems of neighboring cities or towns, and interurban lines which frequently furnish power for lighting and general uses in the town served. There are usually well-marked centres of load which, together with local business conditions, determine the position and equipment of substations.

Railways of class 3, those serving a large city and its suburbs, are also most often the result of the consolidation of separate lines and networks, and while the large central network belongs in class 1, the outlying districts present a difficult problem to the engineer, for he must anticipate the direction, character and sequence of growth so as to provide against it. This requires an intimate knowledge of local conditions, both industrial and social, and in addition he has need to be something of a prophet to foresee the changes which the building of new lines and the starting up of new works may produce. The problem is a local and particular one, and must depend mainly upon individual judgment for its solution.

Classes 1 and 2 can be treated more generally. Take first the case in which a large network, or long line or group of lines, is contained wholly within a large city, so that a fairly uniform schedule can be operated over the whole, and the mean load upon each mile of road is approximately uniform throughout the system, at any given time. It is required to adjust the cost of losses in the primary distribution, the secondary distribution, including the track and the substations, the fixed charges upon each of these three divisions, and the cost of substation attendance, so that their sum shall be a minimum, with due regard to the conditions of regulation and continuity of service.

As the density of the load in such a system is very great, the unit of substation equipment may be made large enough, so that at the time of least load one unit per substation may be operated at or near its best efficiency. Hence the substation losses per kilowatt-hour may be considered constant.

The aggregate capacity of the substations will equal the capacity of the generating station plus the substation reserve capacity, if any is necessary, which will not exceed one unit per substation. The greater the distance between substations, the larger the substation unit will be; hence the cost of substation apparatus will decrease as the number of substations increases, until the largest practicable unit is reached. The same is true of substation land and buildings.

The cost of substation attendance will depend only upon the number of substations, as the same number of attendants is required in a small as in a large substation, unless the cost of land makes it necessary to double-deck the substations, which will cause a sharp rise in the cost of attendance when the number of units becomes greater than can be placed on one floor.

When direct-current motors are used the secondary voltage is fixed by conditions of standard practice. The secondary conductors may be proportioned by Kelvin's law, subject to the limiting condition that the lowest potential shall be enough to allow the required acceleration. As the number of substations increases, the cost of the conductors will decrease rapidly. The energy losses in the conductors may be constant or decreasing. The primary distribution in this case must be by underground cables. The primary voltage will be determined by the relative cost of copper and insulation, and should be as high as is consistent with safety. Hence the losses per mean kilowatt in the primary distribution may be considered constant. The total weight of primary conductors will be practically independent of the number of substations, depending upon the total energy and the mean distance of distribution, and may be determined by Kelvin's law.

To obtain the greatest reliability of service, each substation should be fed directly from the generating station by at least three cables, and in the case of a wide difference in the number of substations considered, the total cost of cables and conduits would be somewhat greater with the larger number of substations as more and smaller cables would be required. Otherwise the cost of the high-tension distribution and the losses in it may be considered constant.

Neglecting those quantities which are constant, the fixed charges on substation land, buildings and apparatus, and the cost of substation attendance increase as the number of substations increases; the fixed charges on the secondary distributions decrease and the losses in the secondary distribution decrease or remain constant.

The various losses and charges upon which the solution of the problem depends may then be considered as constants or variables dependent directly upon the number of substations and inversely upon the distance between substations. These quantities may be reduced to a common base of annual kilowatt-hours, and curves representing them may be drawn with respect to the number of substations as one coordinate, and a summational curve may be drawn which, if the premises are rightly chosen, will indicate the number of substations at which the sum of the various charges is a minimum.

In a far greater number of railways the load is not uniform throughout the system. This is true especially of the long interurban railways using a comparatively small number of heavy train units. The load at any given time is concentrated upon parts of the system, or travels from end to end of the long lines. In such a

[1] A paper presented at the 202d meeting of the American Institute of Electrical Engineers, New York, December 15, 1905.

system the aggregate capacity of the substation apparatus in operation at any given time is greater than that of the generators; hence, the load-factor of the substation is unfavorable, and in most cases the power-factor of the system is low.

In a solution by the method outlined in this paper several new curves must be drawn in addition to those named. The first showing the all-day losses in the substation apparatus, which will increase with the number of substations. The second showing the losses in the primary transmission lines, which will also increase with the number of substations, due to the greater length of lines and to the lower power-factor. The third showing the fixed charges on the primary transmission lines.

The last two curves are relatively much less important. It is possible by compounding or automatic adjustment of fields to keep the power-factors of the synchronous converters very near unity, making the transmission losses more nearly constant and independent of the number of substations. In such systems it is not usual and seldom practicable to use separate feeders from the generating station to each substation; and the primary distribution is usually by overhead lines, generally supported on poles which are used for other conductors as well. But with all the substations along a single line of railway, or a group of such lines connected to one transmission line, the additional cost of extending the same for a greater number of substations will usually be but a small part of the whole expense. So, for at least a preliminary consideration of the problem, the last two curves may be omitted and the same quantities used as are considered in the solution for a road having a uniform distribution of load, with the addition of one containing the all-day losses of the substation apparatus.

In systems consisting of long lines with infrequent train service, the cost of attendance and all-day losses in converter substations often becomes so great that the regulation in secondary conductors economically proportioned for standard direct-current voltage will not permit the operation of the required schedule. The usual remedy is to set the substations nearer together, though at the cost of operating economy.

If other conditions still make the use of standard direct-current equipment desirable, it would seem that better economy could be obtained by lengthening the substation sections and using boosters, just as has been found profitable in the supply of such lines of less length from direct-current generating stations. The fixed charges on, and losses in, the boosters should then be included in the curves of substation apparatus.

In the discussion of the method of treating the problem of substation location herein suggested, the usual type of converter substation, with direct-current, secondary distribution, has been kept in mind, but the method is no less applicable to a complete alternating-current system with static substations, in which case the curves of substation losses, attendance and fixed charges, all become flatter, while the higher trolley voltage available permits a wider spacing of substations, without exceeding the limiting conditions of regulation, all of which indicate a better efficiency of substation apparatus and secondary distribution in roads of low and non-uniform load density.

To show this method of treatment more clearly, a simple problem will be discussed by means of it. A typical interurban railway consisting of one long line has been selected, because it suffices to exhibit the method without an excessive amount of labor.

No attempt has been made to determine the quantities used exactly, but only to make them consistent, as in any particular problem they must be determined for the particular conditions encountered.

Assuming the following data, there is required the number of substations to obtain the best operating economy:

Distribution, alternating current and direct current; length of line, sixty miles; service, hourly in both directions, twenty hours per day; schedule speed, thirty miles per hour; stops per single trip, ten; cars on the line, four for eighteen hours, two for two hours; car hours per day, seventy-six; weight per car (approximate),

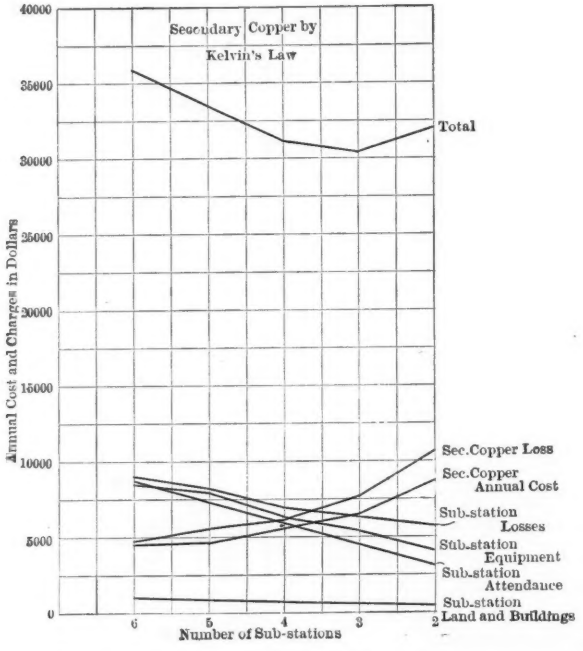


FIG. 1.—SECONDARY COPPER BY KELVIN'S LAW.

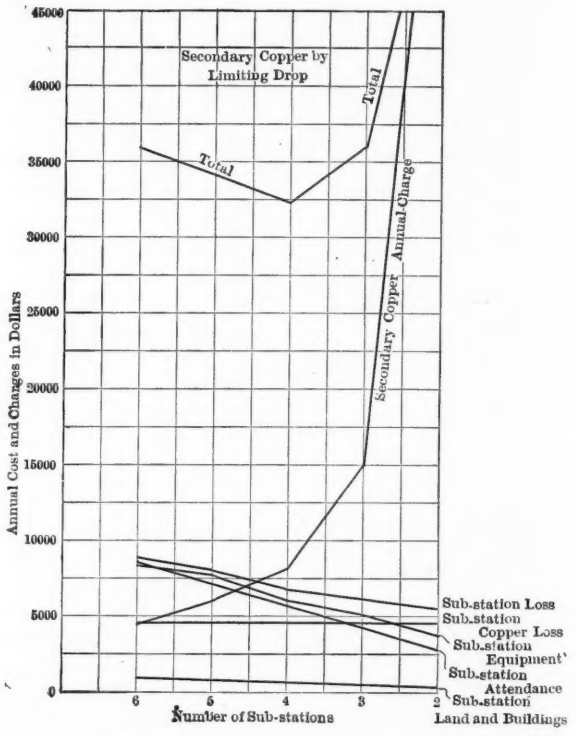


FIG. 2.—SECONDARY COPPER BY LIMITING DROP.

thirty tons; mean amperes per car, 135; mean square amperes per car, 35,000; running current, multiple, per car, 200 amperes; starting current, multiple, per car, 400 amperes; track, single, eighty rails; track resistance per mile, 0.0313 ohm; substation power-factor, one; resistance of copper per mil-mile, 54,750 ohms; weight of copper per mil-mile, 0.016 pound; price of copper per pound, $0.15; rate of interest, five per cent; annual fixed charges on substation buildings and land, seven per cent; annual fixed charges on substation equipment, fifteen per cent; cost of energy at substation, alternating-current bus, $0.0125.

The secondary copper is assumed continuous and of uniform section from end to end of the line.

The substations are arranged so that the drop in the secondary copper and track is the same at points midway between substations and at the ends of the line, the end sections being three-fourths the length of the intermediate sections.

Assuming this line fed through different numbers of substations, it is desired to draw the following curves, with the number of substations as abscissæ and the total annual cost in dollars as ordinate:

Annual charges on substation buildings and land, annual charges on substation equipments, annual charges on secondary conductors, annual cost of substation attendance, annual cost of substation losses, annual cost of losses in secondary conductors and track.

The cost of and loss in the primary distribution are assumed to be nearly enough constant so that they may be neglected in a preliminary discussion, but, if desired, curves representing them may be added to those enumerated.

These quantities have been computed and the curves drawn for the number and arrangement of substations shown in the accompanying tables.

Substation Capacity—With the service outlined the maximum load of any substation will be that due to the starting of two cars at once, 800 amperes, lasting for a few seconds. With the largest number of substations the capacity of each has been made equal to one-half of this, allowing a momentary overload of 100 per cent in case the whole load falls upon one substation. With the smallest number of substations the capacity of each has been made equal to the maximum load. In the intermediate arrangements the capacity of each is graded between these limits in the proportion of the combined line and track resistance between adjacent substations, which is very nearly proportional to the distance between the same.

Substation Losses and Secondary Copper—The mean all-day efficiency of the substations of each arrangement was obtained by dividing the total output of the substations by the total input. The total output was assumed constant at 6,669 kilowatt-hours. The efficiency of each substation at the mean load of one car and at the mean load of two cars, was computed from typical efficiency curves of rotary converters and transformers, allowing six per cent for losses when running idle. From these the mean rates of input and the total input were computed. From the all-day efficiency the cost of energy at the direct-current bus was computed for use in proportioning the secondary conductors by Kelvin's law.

The exact computation of the losses in the secondary conductors is very laborious, so to approximate the same the load was assumed to be fixed at its mean distance from the substation, one-quarter section, and the resistance of the secondary copper multiplied by the car-hours per section and the mean square current per car.

The annual cost of the secondary copper was taken at six per cent to cover interest and cost of reclaiming.

The secondary copper was proportioned by Kelvin's law for each arrangement of substations as follows:

$$\frac{35{,}000 \times \text{car-hours per yr.} \times \text{Res. per mile copper} \times \text{length section} \times \text{cost kw.-hr.}}{4{,}000} = \frac{\text{weight mil-mile} \times \text{Res. mil-mile} \times \text{length section} \times 15 \times 6}{\text{Res. per mile copper} \times 10{,}000}$$

$$\text{Res. per mile copper} = \frac{0.95}{\sqrt{\text{Car-hours per year} \times \text{cost kw.-hours.}}}$$

The annual loss in the secondary conductors and tracks was computed in the same way. The annual loss in the substations' apparatus is given by the difference between the total input and output. In computing the cost of these losses the cost of power at the substation alternating-current bus should be used.

Cost of Substations—The Cost of substation buildings and land was taken at $2,000 each. Switchboards and wiring were estimated at $2,500 per substation. The nearest commercial sizes of rotaries and transformers were used in estimating the cost of substation equipments, at prices varying from $21 per kilowatt for 500 kilowatts to $38 per kilowatt for 250 kilowatts.

Table i and Fig. 1 show the results of this computation, with a minimum operating expense, at three substations, spaced twenty-four miles apart and secondary copper, 746,000 circular mils, which is evidently impossible to operate without the use of boosters in the substations.

Table ii and Fig. 2 show the results of recomputing the same problem, with the secondary copper proportioned to permit a maximum drop in line and track of 300 volts, about the worst condition in which operation is practicable.

It is apparent that economy of operation is usually sacrificed to regulation.

TABLE II—SECONDARY COPPER BY LIMITING DROP.

No. of Substation.	Annual Charges Secondary Copper.	Annual Cost of Secondary Copper Loss.	Totals.
6	4460	4560	35780
5	5850	4560	34050
4	8380	4560	32405
3	15120	4560	36040
2	76400	4560	93770

TABLE I—SECONDARY COPPER BY KELVIN'S LAW.

Substations.				Daily Total Input Kw.-H.	All Day Eff.	Cost Kw.-H. D. C. Bus.	Annual Charges on			Annual Cost of			Totals.
No.	Dist.	Cap.	Com. Cap.	Total Cap.			Real Estate.	Substation Equip'ts.	Secondary Copper.	Substation Attend.	Substation Losses.	Secondary Copper Loss.	
6	10.9	260	250	1560	8500	77.6	1.61	840	8550	4480	8640	8730	4530	35770
5	13.3	281	300	1400	8410	79.3	1.58	700	7780	4550	7200	7960	5450	33640
4	17.1	315	300	1260	8185	81.7	1.53	560	6225	5480	5760	6920	6110	31055
3	24.0	377	400	1131	8070	82.7	1.51	420	5220	6450	4320	6400	7625	30435
2	40.0	520	500	1040	7926	84.3	1.48	280	3900	8690	2880	5750	10420	31920

JHELUM RIVER HYDROELECTRIC POWER INSTALLATION IN BRITISH INDIA.

A DESCRIPTION OF THE WATER-WHEELS AND GENERATOR CONNECTIONS.

The government of British India has for some time pursued a broad-minded policy in developing the latent possibilities of the immense and valuable country over which it exercises sovereignty, and its officials have interested themselves in providing for the future welfare and enlightenment of the native inhabitants. Among other laudable projects which the government has instituted has been the commissioning of some of the most capable royal engineers to plan for and construct public works, such as would aid in the general advancement of the native industries and the development of the commerce of the country.

The first notable project undertaken for the generation and distribution of electricty was that of the Cauvery power scheme, located in Mysore state, in southern India. Work on this plant was started in 1900, the initial installation being completed after many difficulties in June, 1902. About a year ago the second installation or extension of the plant, consisting of 3,610 kilowatts generator capacity, was completed. This increased the possible output of the entire plant to 7,920 kilowatts, making it the largest hydroelectric installation now operating in southern Asia, if not on the entire continent.[1]

The credit for the completion of the Cauvery power plant is largely due to Major A. J. de Lotbiniere, R. E., deputy chief engineer of the government of Mysore, who not only conceived the plan of the installation, but successfully arranged for the financing of the entire project, overcoming prejudices that would have deterred a man less sound in his convictions. He afterward arranged for the purchase of the entire electrical and hydraulic equipment and supervised its installation.

The power scheme next to be undertaken after the Cauvery is the Jhelum power installation on the Jhelum river, in Kashmir, in northwest India. This power plant is to be installed near Rampur, about fifty miles below Srinager, where a six-mile conduit will give a head of water at the plant of about 400 feet. The present plans call for an installation of about 20,000 horse-power.

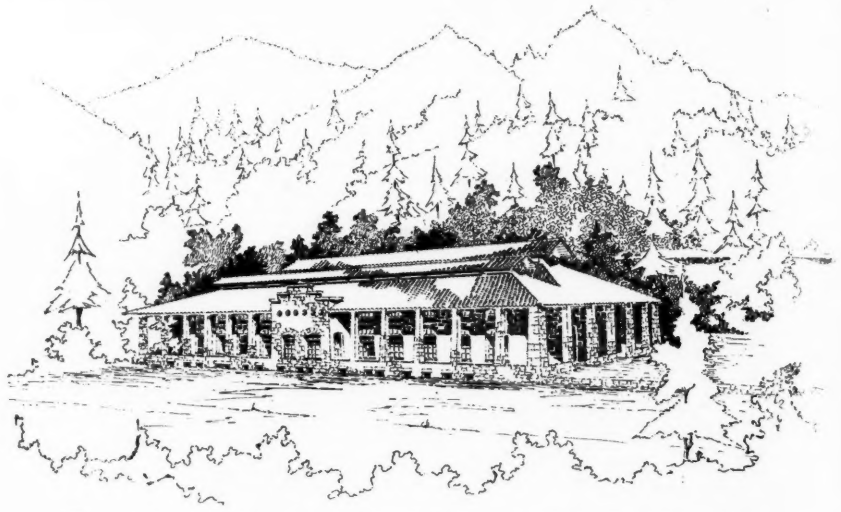
It is planned to use the power for operating the Kashmir section of the Jhelum Valley railway electrically along its entire length of 180 miles. A single-phase system of traction will undoubtedly be installed. Possibly the most important immediate use to which the power will be put will be in operating dredgers for the purpose of deepening the Jhelum river in the Kashmir valley, and thus minimizing the floods, which, under existing circumstances, periodically devastate the entire country. The contemplated plant will also allow of the reclamation of a very large tract of land, and permit of the storage of water in Wular lake, above the power plant, for sale to the Punjab irrigation department. Another important use of the power will be for operating the large silk factory at Srinager and also for supplying with current the electrical water heaters in the silk mill. In addition, the power will be utilized for other industrial purposes and for lighting in Srinager and in Abbottabad, Murree and Rawalpindi, prosperous towns in the British province of Hazara, lying to the west of Kashmir.

After successfully completing the preliminary arrangement for carrying on the important work connected with the Jhelum power installation, Major de Lotbiniere was instructed last May by the Jammu and Kashmir state council, acting for the Maharajah of Jammu and Kashmir, to proceed to Europe and America in order to interview the leading hydraulic and electrical manufacturers and to ask those selected to bid upon the machinery and materials for the plant.

The contract for the hydraulic equipment was awarded to the Abner Doble Company, of San Francisco, Cal., U. S. A., and calls for the hydraulic plant complete from the forebay to the tailrace, including the intake, valves, pressure pipes, pressure-pipe thrust blocks, interior piping, water-wheels and nozzles, hydraulic governors, and all details necessary for the hydraulic equipment. The apparatus and materials are to be delivered at the port of Karachi, India.

The gravity conduit line for the power plant will be approximately 34,000 feet in length, and for the upper 8,500 feet will consist of an excavated ditch lined with masonry. The remaining portion of the water channel will consist of a rectangular flume, or a wooden stave pipe, such as has been installed so successfully in connection with plants of this character on the Pacific coast. The flume will have a capacity of over 500 cubic feet per second.

The forebay at the end of the gravity line and at the head of the pressure pipes will be constructed of masonry and will be provided with special headgates. The sliding elements of the intake gates will be of timber, all iron and metal parts necessary for the construction of the gates being furnished by the hydraulic contractor.



HYDROELECTRIC PLANT ON THE JHELUM RIVER, KASHMIR, NORTHWEST INDIA.

The pressure lines will consist of riveted steel pipes designed with a factor of safety of five, each supplying one of the hydroelectric units. For each pipe line a standpipe and two special vacuum valves will be provided in order to protect the pipe against injury in case the water should be drawn out suddenly.

At the lower end of each pressure line the last length of pipe will terminate in a flange which will be bolted to a massive cast-iron thrust-block that will rest on a heavy cast-iron sole-plate or base. The latter will be mounted on a substantial masonry foundation and held in position

[1] This plant was described very fully by A. C Hobble in [vol. xlvi of the ELECTRICAL REVIEW Nos. 16, 17, 18 and 19.

by anchor bolts. This fitting will be designed to take the entire hydraulic thrust of the pipe, an ample factor of safety being allowed so that under the most severe conditions there will be no strain on the branch piping in the interior of the power-house. Each pressure line will consist of a riveted steel pipe varying in diameter from thirty to thirty-six inches and a fifty-four to thirty-six-inch taper pipe, ten feet long, at the upper end. The pipes will be 790 feet in length, and will deliver the water under an effective head of 400 feet.

The interior piping of the power-house will consist of welded pipe with welded flanges, all piping and fittings beyond the thrust-block being designed with a factor of safety of ten and subjected to a test pressure of one and one-half times the working pressure for a period of five hours.

Twelve main units and three exciter units have been planned for the equipment of the power-house. Each main unit will consist of a Doble tangential water-wheel and automatic oil-pressure governor delivering 1,765 brake-horsepower to the shaft under an effective head of 400 feet. Each wheel will be direct-connected to a 1,000-kilowatt alternator, the speed of the unit being 500 revolutions per minute. The exciter units will each consist of a Doble tangential water-wheel delivering 285 brake-horsepower to the shaft under an effective head of 400 feet. The speed of the exciters will also be 500 revolutions per minute.

The hydroelectric units will be of the Doble standard two-bearing type, the wheel runner being fastened on the end of the shaft. For each of the main units the Doble company will furnish a high-carbon, open-hearth steel forged shaft and two bearings of a special ring-oiling type provided with revolvable bearing shells. The exciter water-wheel runners will be mounted on the extended ends of the exciter generator shafts.

The water-wheels will be equipped with ellipsodial buckets, needle-regulating nozzles and centrifugal water-guards. The regulation of the main units will be effected by means of hydraulic governors operating jet deflectors. For the exciter units hand regulation will be provided by means of the needle nozzles. The gate-valves for each wheel will be of special construction with outside screw and yoke, bronze-mounted, with by-pass.

The power-house will be of solid masonry construction, and will have a wide veranda as a protection from the tropical sun. A double steel roof will be provided, and two traveling cranes will be installed for handling the machinery. The transformers will be installed in a bay of the main building or in a separate structure.

The conditions under which the plant will be installed are decidedly out of the ordinary, as compared with similar work in this country. The specifications for the electrical and hydraulic equipment stipulated that no single piece of machinery should weigh more than four tons when packed, for the reason that there are 200 miles of road transportation, including a lift over a range of mountains 8,000 feet high. Transportation in that section of the country is limited to bullock cart, and no single piece of machinery heavier than four tons can be transported, a total of five tons, including the trollie (cart), being the maximum weight that can be hauled over the mountains.

Portland cement costs $7.50 per barrel delivered at the site, making its use prohibitive for heavy concrete work. However, there is plenty of natural rock in the vicinity, so masonry construction will be used for the walls of the power-house and for the foundations of machines, intake, forebay, etc.

The entire hydroelectric installation will be constructed, erected, tested and placed in operation under the supervision of Major A. J. de Lotbiniere, R. E. Major D. Fraser, R. E., and Captain Thomson, R. E., will act as his engineering representatives in London. Mr. A. C. Jewett, formerly of the General Electric Company, will serve as installing engineer for the government. Mr. Jewett was connected with the installation of the Cauvery plant, and his selection as erecting engineer for the Jhelum river installation comes as a well-deserved recognition of his ability.

With regard to temperature, rubber trees thrive best in Brazil in a mean temperature of twenty-five degrees centigrade, while as to altitude the limit of successful cultivation in Ceylon is placed at 2,000 feet above sea-level.

OSCILLOGRAPHIC RESEARCHES ON SURGING IN HIGH-TENSION LINES.[1]

BY C. DAVID.

When a current is flowing through a circuit containing inductance, energy is stored in its magnetic field, the amount of energy being equal to one-half the product of the inductance into the square of the current. If the electromotive force producing the current be suddenly removed, this energy will dissipate in heat. If the circuit be suddenly opened, the rate of the dissipation of the stored energy will be great, and consequently the electromotive force very high. In addition to magnetic reactance, a circuit will have more or less electrostatic capacity, that is, a certain quantity of electricity is required to charge the line. This energy is stored and will be restored again when the line is discharged. The amount of energy stored is one-half the product of the electrostatic capacity of the line into the square of the voltage. Energy is therefore stored in two ways in a system of electrical conductors.

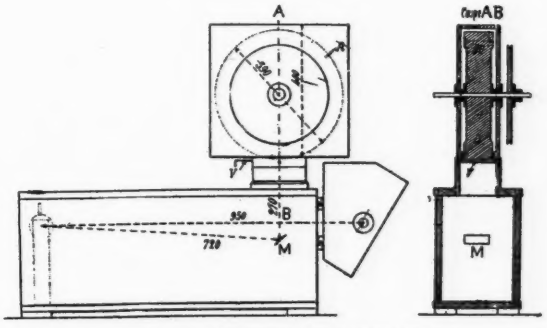


FIG. 1.—MODIFIED OSCILLOGRAPH.

A change of circuit condition taking place as the switching on or off of an additional line, the opening of a circuit with or without load, sudden changes of load, etc., may cause violent and sudden alterations in the energy condition of the circuit, setting up electric oscillations which are liable to give rise to destructive voltages extending over the whole system and causing breakdowns of insulation.

When a transmission line is switched on bus-bars maintained at constant potential, the line may be considered as a condenser with inductance and resistance in series. According to theory (Steinmetz—Transactions of American Institute of Electrical Engineers, 1901,"Oscillations in High-Potential Transmision Lines"), the maximum value of the oscillating electromotive force induced is equal to the impressed electromotive force pro-

[1] Abstracted, with introduction by L. A. Herdt, before the electrical section of the Canadian Society of Civil Engineers, November 2, 1905.

ducing the surging; that is, when a line is connected to a source of electromotive force, the potential may rise to double potential and will then oscillate between this value and zero with continually diminishing amplitude. The amplitude of the oscillations set up depends on the point of the impressed electromotive-force

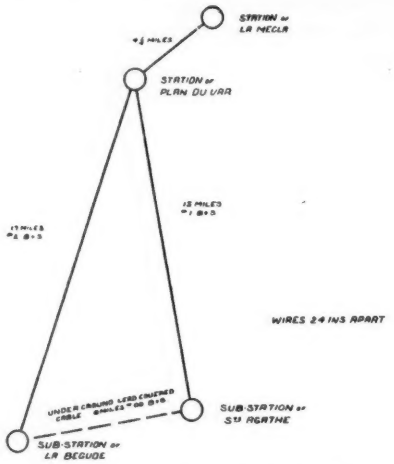


FIG. 2.—DIAGRAM OF TRANSMISSION LINES.

wave at which the circuit switch is closed. Also the frequency of the oscillations set up is independent of the impressed frequency but depends on the line constant.

Theoretically, then, the maximum rise of potential which can occur in connecting a transmission line to the generator bus-bars, when the reflected surge adds to the impressed electromotive force, is 100 per cent.

In practice it will be seldom that the switching takes place when the impressed electromotive force is at its maximum.

When opening a high-tension circuit, the rise of potential will depend upon how

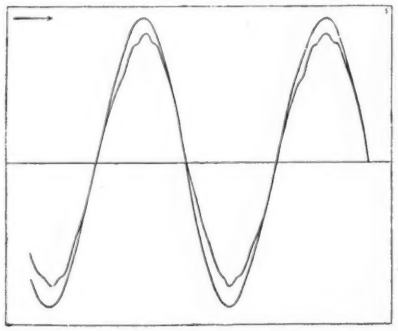


FIG. 3.—"NO LOAD" ELECTROMOTIVE-FORCE WAVE OF THE ALTERNATOR.

suddenly the current is interrupted, and how much magnetic energy is stored in the circuit. This matter is treated by Steinmetz in the paper above referred to, and it is there stated that "the electric oscillations produced by opening a transmission line under load may reach destructive voltages, and the oscillations caused by interrupting a short-circuit are liable to reach voltages far beyond the strength of any insulation. Also that the voltages produced by the oscillations

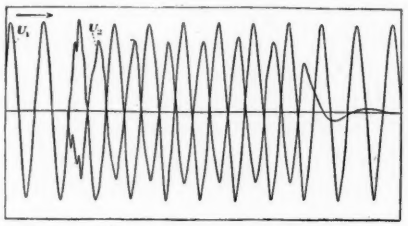


FIG. 4.—ELECTROMOTIVE-FORCE WAVES.

in opening a transmission line under load or under short-circuit are moderate if the opening of the circuit occurs at a certain point of the electromotive-force wave. This point approximately coincides with the moment of zero current."

Electric oscillations may be caused in electric circuits by resonance. In very few cases, however, in actual transmission and distributing circuits, can the rise of potential be attributed to this cause.

Among many papers dealing with the subject of surges on transmission lines,

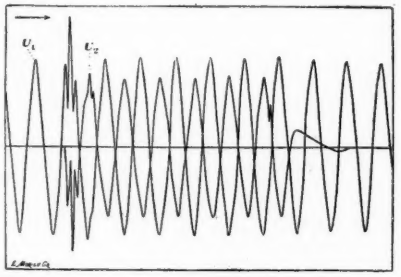


FIG. 5.—LINE SWITCHED ON WHEN ELECTROMOTIVE FORCE IS NEAR ONE-FOURTH PERIOD.

the only one so far giving the result of actual experiments recently appeared in the transactions of the Société Internationale des Electriciens. The paper is by Mr. Charles David, on oscillographic researches made by the Central Electrical Laboratory, Paris, on the high-tension circuit of the Mediterranean Coast Power Company. This paper is very valuable,

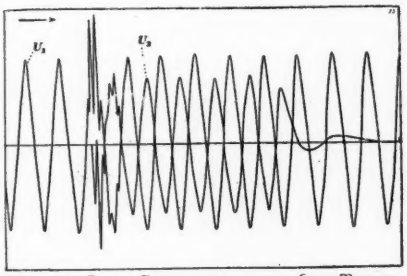


FIG. 6.—LINE SWITCHED ON AT ONE-THIRD PERIOD.

and the following abstract should prove interesting to the members of the electrical section of the society.

The instantaneous values of electromotive force and current were obtained by means of a Blondel-Charpentier oscillograph.

In the ordinary form of oscillographs, the images are obtained on a photographic plate 3.5 inches by 4.5 inches. It was advisable to arrange some means by which the records would be taken for a time sufficient to include conditions not only during the period of surging but for the time before and after.

Instead of the ordinary plate, a film 3.5 inches wide by 4.5 feet long was wound on a wooden cylinder (Fig. 1), placed in a closed box with a shutter and arranged

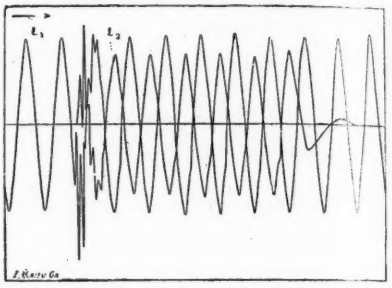


FIG. 7.—LINE SWITCHED ON AT ONE-HALF PERIOD.

so that the images on the galvanometer mirrors could be thrown on the film. This drum was rotated by a small motor, so that the width of a period length as shown on the film could be altered by speeding or slowing the motor. It was thus possible to obtain a large number of periods on one film.

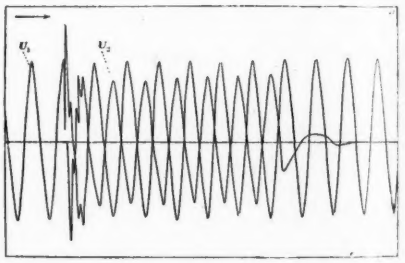


FIG. 8.—LINE SWITCHED ON AT TWO-THIRDS PERIOD.

The transmission lines experimented upon are shown in Fig. 2.

The two stations of Plan du Var and La Mecla operate in parallel. These stations are four and one-half miles distant. The line joining them is overhead, three-phase, three conductors, twenty-four inches apart, No. 1 B. & S. copper wires. From station of Plan du Var two overhead transmission lines, seventeen and fifteen miles long, go respectively to substations at La Begude and Ste. Agathe. The line to La Begude is made up of three conductors No. 2 B. & S., twenty-four inches apart, and that to Ste. Agathe of

No. 1 B. & S. conductors same distance apart.

The substations at La Begude and Ste. Agathe are connected by an underground three-conductor lead-covered cable eight miles long, No. 00 B. & S. conductors.

Capacity in motive force between one conductor and the other two connected to the lead covering, 0.825 per 1,000 feet.

Capacity in motive force between the three conductors joined together and the lead covering, 0.825 per 1,000 feet.

It was thus possible to experiment with a circuit forming a loop of a total perimeter of forty miles—thirty-two miles of

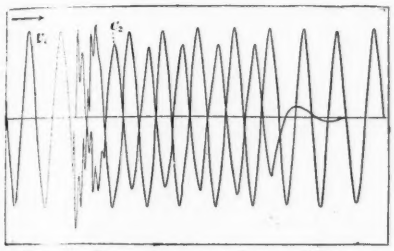


FIG. 9.—ELECTROMOTIVE-FORCE WAVES.

which were overhead, the remaining eight miles underground, the underground part about midway along the loop.

A three-phase 600-kilovolt-ampere, twenty-five cycle, 11,000-volt alternator, driven by a 900-horse-power horizontal turbine, provided the electric power.

The switchboard in the station was equipped with high-tension oil switches, and three-pole air knife switches were also provided.

Fig. 3 shows the no load electromotive-

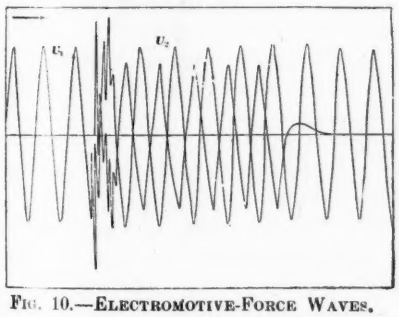


FIG. 10.—ELECTROMOTIVE-FORCE WAVES.

force wave of the alternator, the machine giving an effective voltage of 7,000 at a frequency of twenty-five. The sinusoidal curve is also shown.

In this particular electromotive-force wave the effects of the fifth and seventh harmonics are the only ones noticed and they are quite small, the fifth being less than two per cent of the value of the fundamental one.

The first experiments consisted in making and breaking with an air switch the charging current at the sending end of the line, the charging current being approximately five amperes at 8,900 volts. The forty-mile circuit was unloaded but for a few transformers with open circuit sec-

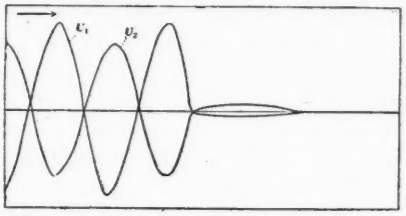


FIG. 11.—ELECTROMOTIVE-FORCE WAVES.

ondaries which were left accidentally on the line.

Fig. 4—U_1 is the electromotive-force wave across one phase at the generator, U_2 the voltage at the end of the line. Waves U_1 and U_2 have been shown in opposition of phase, that is, U_2 is displaced by 180 degrees to show the two curves more distinctly.

The line is shown to have been switched on the bus-bars when the impressed electromotive force is changing sign, and, as would be expected, the oscillations produced are very small. The oscillations

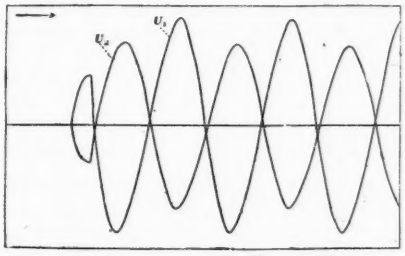


FIG. 12.—ELECTROMOTIVE-FORCE WAVES.

cease in the first half period after the make. When the line is opened there are no oscillations on U_1, but the wave U_2 shows at the rupture a damped oscillation of large period.

Fig. 5 shows the line switched on at the moment when the impressed electromotive force is near one-fourth period.

At first the impressed electromotive force is suddenly reduced, but further a rise of potential takes place, giving a fifty per cent increase of impressed press-

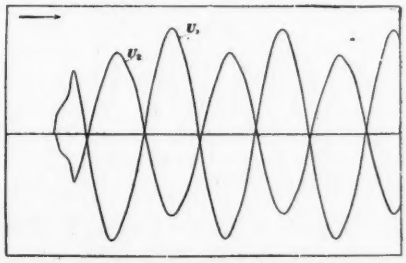


FIG. 13.—ELECTROMOTIVE-FORCE WAVES.

ure. A rise is also shown on wave U_2. The oscillations cease in the first period after the make. Here, again, there are no oscillations in the impressed electromotive-force waves when the circuit is opened, but U_2 shows a momentary surge.

Figs. 6, 7 and 8 show the conditions of U_1 and U_2 when the line was switched on at the moment when the impressed electromotive force is at or near one-third, one-half and two-third period. The surges on both U_1 and U_2 are well shown and are quite large. The rise of potential, however, did not in any one of a large number of experiments exceed fifty-five per cent. The oscillations take place in one period after the make of the switch.

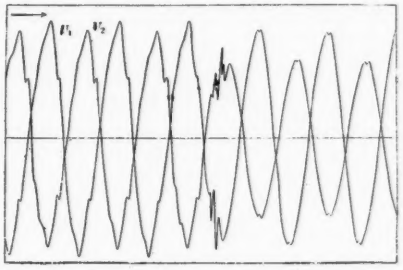


FIG. 14.—ELECTROMOTIVE FORCE OF THE GENERATOR AND DIFFERENCE OF POTENTIAL ON THE LINE SIDE OF SWITCH.

When the switch was opened the voltage never rose, but in all cases the wave U_2 shows a much longer period and is damped out in a single oscillation. The percentage of the number of times in which surging appeared to the total make and break equaled sixty-six per cent.

Records taken on the unloaded line, when operated with an oil switch in place of the air switch, do not differ very much from those just shown.

Fig. 9 shows the value of U_1 and U_2, the unloaded line switched in with an oil

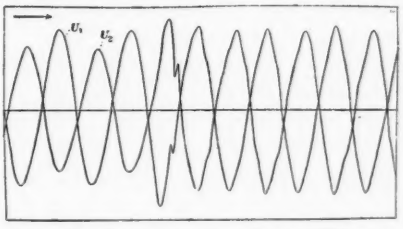


FIG. 15.—ELECTROMOTIVE-FORCE WAVES.

switch at the moment when the impressed electromotive force is near one-half period the rise of potential for U_2, which for the air switch (Fig. 7) was considerable, fifty per cent as near as can be judged, is only about half of that amount. U_2, although it shows considerable oscillations, shows no rise of potential.

Fig. 10 is for a similar load, but the time of switching is near the maximum value of U_1. The rise of potential is sixty per cent for U_1 and fifty-eight per cent for U_2. This is somewhat greater than that obtained with the air switch under similar conditions.

At the opening of the circuit there are

no oscillations or rise of potential in U^1; as for U_2 a damped oscillation of long period takes place in every case.

In twelve different experiments, the rise of voltage for U_1 and U_2 is as follows (line switched in):

U_1 (electromotive force at bus-bars):

1	rise	of	potential	64	per cent
2	"	"	"	60	"
1	"	"	"	50	"
3	"	"	"	25	"
1	"	"	"	18	"
2	"	"	"	10	"

For U_2 difference of potential end of line:

1	rise	of	potential	67	per cent
2	"	"	"	64	"
1	"	"	"	58	"
2	"	"	"	30	"
1	"	"	"	25	"
2	"	"	"	17	"
1	"	"	"	8	"

So far as these experiments go, there is not very much difference whether an oil or an air switch is used. Whenever the switching-in takes place, when the impressed electromotive force is near zero, the rise of potential will be very small. At other times the rise of potential will be considerable and violent oscillations will be set up, disappearing in one period. At the break no rise of potential, under any conditions, has been noticed.

EXPERIMENTS WITH NON-INDUCTIVE LOAD, OIL SWITCH.

Oscillographic records are given for first, the switch placed between the generator bus-bars and the line; second, switch placed between the line and the load. A three-phase water rheostat was placed at the end of the line as a load.

The experiments under load were carried out in the following manner. The alternator was loaded through the forty-mile line on the water rheostat. The switch was then opened for one-half second and then closed. The load was adjusted to twenty-two amperes, a voltmeter on the line side of the switch reading U_1 (7,200 volts on one phase), and a voltmeter placed on the rheostat reading U_2 (6,200 volts).

Fig. 11—The opening of the switch is shown to have taken place when U^1 was zero. No rise of potential. Other records show similar results. The break is always shown to take place at zero value of impressed electromotive force. Mr. David

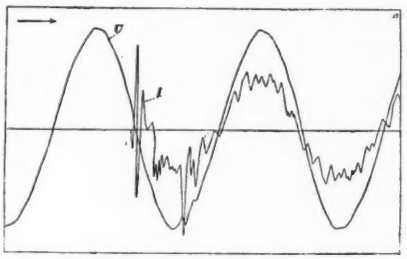


FIG. 16.—ELECTROMOTIVE-FORCE WAVES.

is uncertain as to whether this is due to the oil switch or pure hazard.

In Figs. 12 and 13, waves U_1 and U_2 are shown when the switch is closed. There is no surging or rise of potential. The régime is steady after the first period following the close of the circuit.

HIGH-TENSION OIL SWITCH PLACED AT END OF LINE.

The oil switch was placed between the receiving end of the line and the rheostat, so that the alternator was kept on the line when the load was switched off.

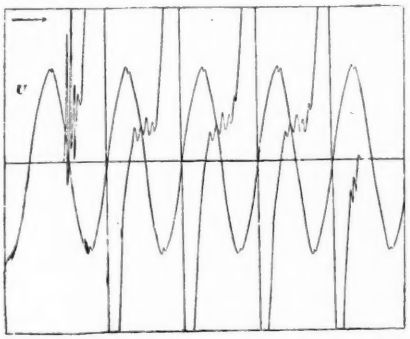


FIG. 17.—CABLE SWITCHED ON WHEN IMPRESSED ELECTROMOTIVE FORCE IS ABOUT CHANGING SIGN.

In Fig. 14, U_1 and U_2 are respectively the electromotive force of the generator and the difference of potential on the line side of the switch (U_1 = 7,300 volts, U_2 = 6,100 volts, the current 26.5 amperes). Oscillations are shown on U_1 and U_2, but without rise of potential.

Fig. 15 gives values of U_1 and U_2 when the switch is opened. The rise of voltage on U_1 is twenty-four per cent and eighteen per cent for U_2. Oscillations take place in the time of the period corresponding to the unswitching. In the course of a large number of experiments under similar conditions of load no rise of potential ever took place at the switching in. At the unswitching, however, the increase lies between fifteen and twenty-four per cent. The percentage rise of potential is usually greater at the sending than at the receiving end.

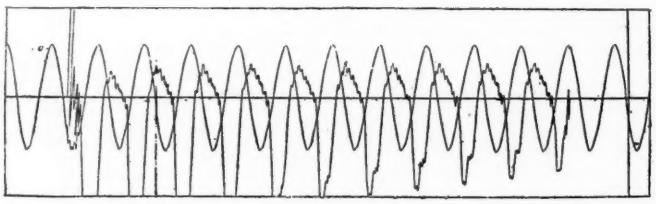


FIG. 18.—SWITCH CLOSED AT ONE-THIRD PERIOD.

AIR SWITCH.

Experiments were carried on with an air switch, this switch being of special make, allowing the arc made at the break to rise between copper horns, increasing the length of the arc until it broke. The records show that the rise of potential with this switch is considerably greater than with the oil switch under similar conditions of load and that the oscillations are kept up for at least two periods after the opening of the circuit.

EXPERIMENTS WITH AN UNDERGROUND CIRCUIT.

The cable experimented with is a three-conductor lead-covered cable, four miles long.

The cable unloaded was switched on the bus-bars through an oil switch and records of electromotive force and current are shown in Fig. 15.

Bus-bar voltage 9,700. The current value is not given, but could not be more than a few amperes.

In Fig. 16, U the electromotive-force wave shows little oscillations, not so with the current wave I. Rapid oscillations take place during the first half period corresponding to the closing of the switch.

A 200-kilovolt-ampere transformer with secondary winding open was then connected to the end of the cable.

Watt transformer input 4,500; applied voltage, 9,600; (the current is not given).

Fig. 17 shows cable switched on when the impressed electromotive force is about changing sign. The electromotive-force wave shows no oscillations. The current wave shows violent ones. The maximum values of the current exceeded the width of the film and are not recorded on this plate. The negative and positive waves are dissimilar and the distances between the zero values are unequal. The switch was opened after an interval of four periods, the current had not then taken its normal value.

Fig. 18 shows electromotive force and current waves for a similar test, but the switch closed at one-third period. Small oscillations are shown on the electromotive-force wave. The current wave is again very erratic, starting with a large rise of

current, followed by a series of rapid oscillations. The circuit was opened at the end of the eleventh period, but the current had not taken its normal value. The effect of the unswitching is shown by a small oscillation of the electromotive-force wave.

A number of experiments were taken and show similar results. In all cases it is shown that the electromotive-force wave suffered very small disturbance at the closing or opening of the circuit, but the current waves show violent oscillations.

These experiments are not sufficient to arrive at definite conclusions, but they show that there is a danger of overvoltage when a transmission line is thrown on generator bus-bars except when the switching in is done at or near the moment when the impressed electromotive force is zero; there is no danger of overvoltage when the line is switched off, the charging current being usually small.

There is danger of overvoltage when a loaded line is switched off the high-tension bus-bars and the oil switch is likely to prove less dangerous than the air-switch.

The Faraday Society.

The seventeenth ordinary meeting of the Faraday Society was held on Tuesday, December 12, 1905, at the Institution of Electrical Engineers, 92 Victoria street, London, S. W. Mr. James Swinburne, vice-president, was in the chair.

Mr. J. Swinburne and Dr. G. Rudorf presented a paper on "The Physics of Ore Flotation."

The flotation of ores to separate them from gangue is carried out by treating them with dilute acid or acid sodium sulphate, at a temperature short of boiling water. Little bells of CO_2 attach themselves to the ore particles, but not to the gangue, and the ore particles are floated to the surface, where they are skimmed off. The questions are why the sulphides are selected and why the temperature matters. Though other theories have been proposed, the action is evidently capillary. The authors hold that it is a question of two opposing forces—adhesion between the solids and the liquid which varies with different solids and liquids, and surface tension of the liquid. Surface tension tends to reduce the liquid surface necessary to contain the gas to a minimum, by arranging the solid particle so that it forms part of the containing-surface. Adhesion, on the other hand, tends to immerse the particle more, and to detach the gas bell. The two forces thus act in opposition. Raising the temperature reduces both forces; but while the surface tension vanishes only at the critical temperature, the adhesion appears to vanish about the boiling point; by raising the temperature, therefore, the adhesion is sufficiently reduced for the surface tension to overcome it, and the attached gas bells then lift particles. Even then particles with small adhesion will alone be raised.

The phenomenon of adhesion seems to be intimately connected with that of the air-film. Surface tension produces an extra pressure on the gas in a bell, and if the bell is very small the pressure is very great, so that it is difficult for the bell to start. The air-film may give it a chance of starting.

The difference of adhesion to dilute acid or water of various minerals is considerable. Thus galena is more difficult to wet than silica, and so on; and those ores alone can be concentrated by flotation which contain some such ingredients which is either attached to the valuable constituent or is itself valuable.

The gas is CO_2, which is produced by decomposing carbonates; it is not H_2S. The carbonates are probably produced by slight weathering of the ore.

Professor A. K. Huntington then read a paper on the same subject entitled "The Concentration of Metalliferous Sulphides by Flotation." The paper also embodies the author's contribution to the discussion on the previous paper.

The paper has reference to the flotation processes of Potter and Delprat, which have been successfully applied in practice to the further concentration of the "tailings" obtained in the treatment of the sulphide ores of the Broken Hill district. These ores consist of sulphides of lead and zinc carrying silver, with a gangue composed of quartz, rhodonite, garnets and small quantities of carbonates.

The flotation process consists in adding to the tailings dilute sulphuric acid (Potter), or a solution of acid sulphate of soda (Delprat) at about sixty-five degrees centigrade. Under these conditions the metallic sulphides are floated up by attached bubbles of gas and form a coherent scum which can be removed, leaving behind the gangue, the separation being practically a quantitative one.

Experiments are described which prove that the gas causing flotation is CO_2 derived from native carbonates of iron and manganese present in the ore, and not from calcite or from carbonates produced on the surface of the sulphides by weathering. Carbonates which are decomposed by dilute sulphuric acid in the cold do not give rise to the formation of a scum.

Experiments are also described, showing that the gas escaping during flotation carries an electrical charge, leaving an opposite charge on the solution. Electrometer determinations of the charge were made, but it was not found possible to establish a direct connection between the electrical phenomena and the fact of flotation. No change in the surface tension conditions of the solution in contact with a metallic sulphide is to be observed on electrification.

The assumption of Messrs. Swinburne and Rudorf of the presence of an air-film on the surface of the sulphide particles is criticised, and it is shown that the particles are floated perfectly after precautions have been taken to remove any adherent film of gas by exhaustion with acid, washing with alcohol, treatment with air-free distilled water and exhaustion with the pump, etc. Flotation depending on the presence of an adhering film of air is made use of in certain suggested concentration processes, which, however, are different in principle from those under consideration.

It is a curious fact that specimens of zinc blende containing but little gangue, which do not form a scum on treatment with sulphuric acid and carbonate of iron, give an excellent flotation if previously mixed with sand. On the other hand, too great dilution with inert matter injures the flotation. The Broken Hill banner tailings appear to be ideally suitable for the flotation process. These experiments dispose of Messrs. Swinburne and Rudorf's contention that blende scarcely floats at all and incidentally of the statement that "zinc blende is thus easily raised by galena when intimately associated." They themselves admit that galena has to be very finely pulverized to float successfully; it is difficult therefore to see how it could be expected to float with attached inert blende. It appears more probable that the blende helps the galena to float. This view was strengthened by some experiments made on the wetting of sulphide surfaces.

The degree of wetting of a surface may be judged by measuring the angle which the liquid makes with it. Direct determinations of this angle for different minerals by a goniometer method are described, the values obtained varying from forty-seven degrees to sixty-three degrees for different sulphides. Quartz and magnetite are completely wetted by water. Alcohol wets all sulphides, but on again

placing in water the apparent "greasiness" is restored.

When a gas bubble comes into contact with a mineral particle, the extent of surface of the bubble which will be in contact with the solid depends on the angle of contact of the solid with the liquid. If the angle is such as to cause a relatively large surface of the gas to be in contact with the solid, and the bubble is sufficiently large, the particle will be floated. The less the wetting the greater will be the force required to detach the bubble. If the surface of the solid is wetted, the bubble has no attachment at all. The different conditions met with are illustrated by means of diagrams.

Mr. Bertram Blount said, although unable to put forward a satisfactory theory of his own, he was unconvinced by those proposed by the authors. Nor did their theories help in practice, for the only way to discover whether the flotation process could be applied to a particular ore was by experiment.

Mr. J. G. A. Rhodin thought that the crux of the theoretical difficulty was to discover how the gas bells were able to break through the liquid surface-films on the solid particles so as to come into contact with the latter; once that was known, Quincke's formula for triple contact of gas, liquid and solid could be applied. The key to the problem lay in the application of the law of mass-action, the necessary condition being that the solid must partly go into solution. The occluded or condensed gases which it is practically impossible to remove from the surface of a solid helped the action.

Dr. O. J. Steinhart referred to oil separation processes. He also pointed out that no separation process could be considered entirely satisfactory which did not separate galena from blende.

Mr. F. S. Spiers described some measurements of the Volta effect between metals in so-called vacuo, which illustrated the difficulty, if not impossibility, of removing condensed air-films from the surfaces of solids.

Dr. F. Mollwo Perkin remarked on the differences between occlusion and surface-condensation of gases.

Mr. N. J. Bluman said that the theories put forward did not explain the selective action of the air-bubbles.

Mr. R. Frederick Yorke thought that an electrostatic theory would be required to explain the selective action.

Dr. H. Borns hoped that more experiments would be made, so as to explain some of the anomalous effects observed by Professor Huntington.

Dr. G. Rudorf said that Mr. Swinburne and he did not claim "weathering" as absolutely essential, with reference to the contact angle made by a liquid with a solid that itself depended on the air-film.

Mr. J. Swinburne said that the essential point which the theory Dr. Rudorf and he had put forward was the temperature effect. No theory could explain the differences in the action on the different constituents of the ore any more than one could the differences of specific gravity; these depended on the varying inherent properties of matter. The presence of an air-film was not necessary, if the particles to be lifted were "greasy."

Professor J. Walker, F. R. S., contributed a paper on "The Ions of Pure Water."

In the discussion on Dr. Lowry's paper on "An Application to Electrolytes of the Hydrate Theory of Solution," Mr. Bousfield drew attention to an apparent discrepancy between the temperature coefficient of the mobility of hydrogen and hydroxide ions on the one hand, and the temperature coefficient of the conductivity of water on the other. The author points out that the water for which the data used by Mr. Bousfield hold good owes its conductivity almost wholly to impurity, and that Mr. Bousfield in his theoretical deduction has neglected the effect of temperature on ionic concentration. When the data obtained by Kohlrausch for pure water are employed, and when allowance is made for the temperature coefficient of ionization, the discrepancy vanishes.

Mr. W. R. Bousfield (communicated) said that he did not profess to be dealing with pure water, but with "water" in inverted commas. But he agreed now that there was strong evidence that pure water had a genuine conductivity due to H and OH ions.

The Electrical Equipment of a Machine Shop.

In a recent article in the *American Machinist,* New York, description is given of the new plant of the F. Wesel Manufacturing Company, of Brooklyn, N. Y. This company makes all machines and tools used by electrotypers and stereotypers. A feature of the equipment is the use of the motor-drive in place of belts. This has been done in a very thorough manner. It is said that the average load carried by the generators is 150 horse-power, although the rating of the motors aggregates not far from 400 horse-power. The company says that from its experience the amount of power which would be consumed by the machine tools using the belt drive would be 300 horse-power; hence there has been a saving of half, due to the electric drive. Another interesting feature of this shop is the use of electric welding for making printers' chases. These chases are made up of bars of wrought iron welded together so as to form rectangular frames, in some cases with intermediate bars. As they are of all sizes and styles, they are not carried in stock, but are made to order as wanted. The wrought-iron bars are sawed to length and planed at the ends and on what is to be the inner edge. They are then placed in a welding machine and welded. From this they are carried to rectangular vises, so that they cool true and square. The welding machine takes 300 amperes at 320 volts. After welding, the chases are placed in a milling machine, which removes the burr; then in a mortising machine for cutting the inner corners square. This method of manufacture is said to be most satisfactory, since it is quick and produces a true article.

Mexican Government Adopts Telefunken Wireless System.

After an exhaustive examination and nearly three years' experience with the wireless telegraph apparatus installed by the Telefunken Company in 1902, at Rosalia and Guaymas, Mexico, the Mexican government has awarded this company another contract. The Rosalia and Guaymas plants have enabled the government to maintain an uninterrupted communication across the Gulf of California. The points to be connected under the new award are Mazatlan, Sinaloa and San Jose del Cabo, the distance being about 325 kilometres. The contract provides for several fixed and distinct wavelengths, as stations are both for communication between themselves and shipping. It is expected that in view of the very satisfactory results already obtained with this system, and the fact that the government now has at its command a trained staff of wireless telegraph experts, that other contracts will follow these two.

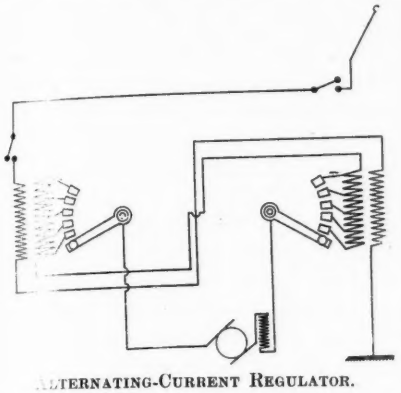
New York Electrical Society.

The next meeting of the New York Electrical Society will be held at Columbia University, New York city, January 16. Mr. William Marconi will lecture on "Ether Telegraphy."

This is the first of a series of very interesting lectures which the society will hold during the year. An announcement of the other subjects was made last week.

Electrical Patents.

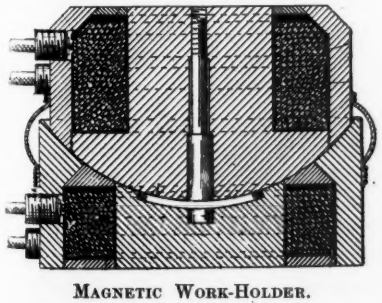
Giorgio Finzi, Milan, Italy, has obtained a patent (807,545, December 19, 1905) for an improved alternating-current regulator. The object of this invention is the employment on alternating-current transformers of a regulator in which no interruption of the main circuit takes place,



ALTERNATING-CURRENT REGULATOR.

and the object has been to minimize the short-circuit current in such a manner that it can not detrimentally affect the transformer or cause sparking which will attack the contact-pieces, when interruption takes place. In vehicles driven by alternating electric currents and having a platform at each end, the combination of a switch adapted for the maximum voltage which corresponds to the minimum working voltage and mounted on one platform, of a similar switch mounted on the other platform, and electrical connections between the two switches, and means which cause the switch that is in the temporarily rear platform to remain at said minimum voltage while the switch on the then front platform serves to effect the regulation between this voltage and the maximum working voltage and also the interruption of the circuit.

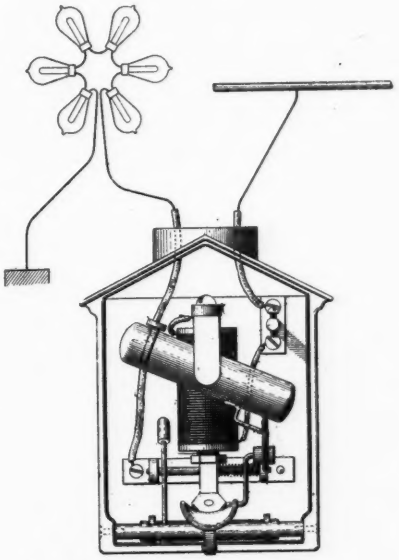
An improvement in a magnetic work-holder has been invented by Walter N.



MAGNETIC WORK-HOLDER.

Vance, of Chicago, Ill. (807,517, December 19). The present invention is a magnetic work-holder for holding iron to be worked upon by machine or other tools, and it is specially designed for holding work upon milling and shaping machines and machine tools of that kind. The said invention consists of two polar surfaces, one for engaging the iron table and one for engaging the work to be held, the holder being made in two parts, one part to rock upon the other to better adjust it to the configuration of the work to be held, the joint between the two parts being a spherical one which will permit the part to rock in any plane, combined with means which may be applied at will to restrict the motion of each part to rocking in a single plane like a cylindric joint, and means for preventing one part from rocking on the other.

Gwynne E. Painter, Baltimore, has obtained a patent (807,684, December 19, 1905) on an improved circuit-controlling device. The invention relates to a circuit-controlling device, and has been devised more especially for use in connection with an electric signaling device or apparatus designed to be used by patrons of suburban railways for stopping an approaching



CIRCUIT-CONTROLLING DEVICE.

car. In the United States patent 681,371, granted to Mr. Painter, August 27, 1901, there is shown and described a signaling apparatus designed for the purpose indicated, in which a signal is displayed by manually closing a normally open circuit by means of a switch, the signal being thereafter extinguished by means of a device, which is operated by a passing car, for causing the signal-controlling switch to return to its normal open position. The present invention has been devised with a view to dispensing with the car-operated signal-extinguishing device shown and described in the prior patent, and to this end he has constructed a circuit-closing device which will automatically open the circuit at the expiration of a predetermined interval of time after this circuit has been closed, so that a signal controlled thereby will be displayed a predetermined length of time and then be automatically extinguished. The invention consists in the combination with a circuit-closing switch of an electromagnet normally within the circuit controlled thereby and adapted when energized to hold the switch in its closed position and timing mechanism adapted to automatically short-circuit the magnet at the expiration of a predetermined interval of time after the circuit has been closed.

BOOK REVIEWS.

"La Theórie Moderne des Phénoménes Physiques." Augusto Righi. Translated into French by Eugene Néculcéa. Paris. L'Eclairage Electrique. Paper. 126 pages. 5½ by 9 inches. 19 figures. Price, 3 francs.

This is a treatise on the recent discoveries concerning the electronic theory, radioactivity, and modern views upon the constitution of matter. The author's presentation of the subjects was so clear and thorough that his work has been thought worthy of translation into French, which has been done, the second edition being used for this purpose, and the translation being made somewhat freely. The author has cooperated with the translator, and has reviewed the French edition.

"Telegraphy." T. E. Herbert. New York. The Macmillan Company. Cloth. 912 pages. 5 by 7½ inches. 509 illustrations. Supplied by the ELECTRICAL REVIEW at $2.60.

A very complete treatise is this book on telegraphy. The author, who is an engineer of the British post-office department, takes up the subject from the British point of view, devoting himself almost entirely to the systems there employed. He, however, describes in a detailed manner all important telegraphic methods, giving with each description a summary of its advantages and disadvantages. A good deal of attention is also given to auxiliary appliances. The British post-office switchboards are described, methods of caring for storage batteries are explained, as well as the systems in which storage batteries are employed. Protective devices and methods of locating faults are duly considered, the explanation generally being made clear by a numerical example. There is a long chapter on the construction of aerial lines, which describes the various appliances used and the method of erection. There is also a chapter on conduit systems. The book is furnished with an excellent index, and should be a valuable guide and text-book for the English student.

Reviews of Current Engineering and Scientific Literature.

The Conversion of Disruptive Discharges into Constant Currents.

Some years ago Herr W. Holtz attempted to obtain a constant current from the discharge of an induction coil. As is well known, the secondary current of such a coil is exceedingly irregular. He thought that by adding to this circuit certain electrical apparatus he might be able to obtain a steady current. He used as an analogy the hydraulic ram, in which there is a large flow of water at a low head, which, by means of a valve, gives an intermittent high-pressure discharge, small in quantity. This intermittent discharge, by means of an air chamber and a long discharge pipe, is converted into what is practically a constant flow. In place of the valve, Herr Holtz used an electric valve, obtained by passing the discharge between points and plates through a flame. The air chamber was represented by a condenser, and the long discharge pipe by a high-resistance circuit. His attempts were without avail. Somewhat later, when the electrolytic valve was discovered, he attempted to use this in place of the previous type of valve, again without success. Even when he placed several of these valves in series, he was unable to obtain a constant current in the secondary circuit. Since his last attempts other types of electric valve have been invented, but he has been unable to try the effects of these, though he thinks the experiment will be an interesting one. —*Translated and abstracted from Physikalische Zeitschrift (Leipsic), December* 15.

Long Telephone Span at Kansas City.

The heaviest telephone span in the West is at Kansas City, Mo., across the Missouri river. A description of this span is given here by Mr. C. R. Baldwin. The distance between the towers is 1,335 feet. The towers themselves are of the windmill type, each eighty feet high. They carry at the top a heavy frame constructed of cross-arms. At the point where the span crosses there are high bluffs on each side, so that by carrying the strain wires back to these points but little strain is thrown on the towers. There are fifty wires in the span, each being No. 8 steel wire. The lines are carried straight back from the towers to poles, where the steel wire is dead-ended on a glass circuit-breaker. At this point the regular telephone wires, consisting of No. 12 copper, are connected on and carried to the exchange. The circuit-breakers are each fastened to a three-eighths-inch steel messenger wire, which runs to a pole 100 feet further on. From this pole the wires are carried back to a heavy rack made up of four-inch by four-inch timbers. This rack is guyed by ten one-half-inch steel messenger wires, coming together at a point twenty-five feet further on, and fastened to a heavy steel anchor set in concrete. The dip of the wires in the main span is fifteen feet. They are used for handling the toll business from Kansas City to points north. During the floods of 1903 these were the only lines crossing the river that were not put out of service. Each wire in the span weighs 390 pounds per mile, so that the load on the towers is large.—*Abstracted from the American Telephone Journal (New York), December* 23.

The Oxyacetylene Blowpipe.

A report is here given of an investigation by the Bureau Veritas, of Paris, of the value of the oxyacetylene blowpipe for welding and soldering. This apparatus is intended to replace the oxyhydrogen blowpipe. The advantages claimed for it are the higher temperature obtainable, this being in the neighborhood of 4,000 degrees, while that of the oxyhydrogen flame is only about 2,500. Moreover, the cost per calorie of heat is less. A cubic metre of acetylene gives up about 14,700 calories, while a cubic metre of hydrogen develops only 3,100. Another advantage is that the flame can be regulated easily, because, with slight changes of the supply of oxygen, great changes in its appearance take place. The flame can be made to give an oxidizing or reducing effect. The apparatus has some advantages over the oxyhydrogen apparatus as regards its construction, since the gas may be developed in a generator at low pressure without danger. All that is necessary is that the pressure should be so great that the gas issues from the burner at a speed greater than the propagation of the flame. The oxygen can be drawn from charged tanks as usual, or it may be obtained by chemical reactions. Some of the recent chemical reagents which give off oxygen when brought in contact with water are particularly convenient. The opening of the burners employed in the tests varied from nothing to four square millimetres. An opening of about 0.6 square millimetre gives a consumption of fifty-five litres per hour, while an opening of four square millimetres consumes 2,300 litres. For welding thin sheets together the flame is brought in contact at two or more points of the edge, so as to fasten the sheets in place. The whole joint is then exposed to the flame, and when the temperature has been raised to a sufficient point the pieces are pressed together. For sheets thicker than two millimetres a solder is employed, consisting of a wire of the same material. The parts to be joined together are heated by the flame, and when hot this wire is introduced into the flame. It melts, flows between the two parts, and joins them solidly together. It was found that the time required to join two pieces together, each one millimetre thick, was six minutes per metre of joint. The consumption of the gases was nine litres. Sheets two millimetres thick required eight minutes per metre of joint, consuming twenty litres of each gas. Sheets ten millimetres thick required fifty minutes per metre of joint, consuming 460 litres of each gas. Sheets thirty millimetres thick required three hours per metre of joint, and consumed 7,200 litres of each gas. After the joints had been made they were tested for mechanical strength. These tests justify the use of this method for a wide range of work.—*Translated and abstracted from La Revue Technique (Paris), November* 25.

A Study of the Theory of the Heusler Alloys.

Some interesting suggestions are made here by M. C. E. Guillaume, to explain the magnetic behavior of the so-called Heusler alloys. M. Guillaume first reviews our knowledge of alloys in general. He points out that an alloy melts at a lower temperature than at least one of its component metals. Generally the fusing point of the alloy for a wide range of composition is lower than that of either one of the metals which go to form it. These fusion-temperature characteristics generally show two points where the fusing point is a minimum—that is to say, starting with one metal—antimony, for example—and adding to this copper, as the percentage of copper increases the fusing point of the alloy will fall below that of antimony until a certain point is reached. Here there is a sharp bend in the curve, and the fusing point rises with each increase in the amount of copper added. It then turns down again to another

minimum point, and after this rises rapidly until it reaches the fusing point of copper, at this point there being no antimony in the material. These so-called eutectic points correspond to definite proportions of the alloys. To this general law there are three noteworthy exceptions. One is the alloy of antimony and aluminum, which throughout almost the entire range of proportions has a higher fusing point than either of its component metals. Sodium and tin behave in the same way, as does also the gold-aluminum alloy. These exceptions seem to M. Guillaume to be significant when studying the Heusler alloys. As is well known, the magnetic qualities of iron, cobalt and nickel change with temperature, and there is for each of these metals a critical point where the substance becomes practically non-magnetic. To the same group of metals belong manganese and chromium, which are constituents of two of the Heusler alloys. These alloys contain also either aluminum or tin, and it is suggested that manganese and chromium might be magnetic at very low temperatures, and that aluminum and tin have the property of raising their critical magnetic points just as the latter two metals raise the critical fusing points of sodium and gold alloys. The fact discovered by Faraday is considered significant also, which is that the salts of chromium and manganese have magnetic properties of the same order as the corresponding salts of iron, nickel and cobalt. Another fact is significant also, which is the process of cooling of the alloys. Except at the eutectic points, cooling proceeds by crystallization first. The process of one alloy over a definite composition crystallizes out, and at a lower temperature the true alloy solidifies. As is well known, the magnetic quality of iron depends upon its physical state, and is thought to depend largely upon the crystalline character of its structure. It seems possible that these two facts are somehow related.—*Translated and abstracted from L'Industrie Électrique (Paris), December* 10.

Separation of Iron and Friction Losses in Direct-Current Machinery.

The methods usually employed for separating the iron and friction losses in direct-current machinery are those due to Hopkinson and Swinburne, but neither of these is thought to be as simple as a modification of the Kapp method which has been devised by Mr. F. H. Page. In the Kapp test two machines are required, one acting as a motor to drive the other, which is tested. First, by running the motor at different speeds, the total losses of the motor are obtained; second, by running the motor driving the generator unexcited at different speeds, the total losses of the motor, plus the friction loss of the generator, are obtained, and by subtracting the watts input given by the first test from those given by the second at any required speed, the frictional loss at that speed is at once determined. To find the iron loss at different speeds it is necessary to take a third test with the generator excited from a constant excitation. An increase in the watts input at any speed is equal to the iron loss at that speed. The author's modification of this test consists in coupling together two machines of similar type, size and voltage. One of these is run as a motor, driving the second, which is unexcited. The speed of the motor is varied by altering the shunt excitation, and simultaneous readings are taken of the armature amperes, volts, the excitation and speed. The fields of the two machines are now put in series across double normal voltage of one machine, and a second test carried out exactly similar to the first, with the exception that the exciting current now passes through the fields of the second machine also. From these tests two curves may be plotted, getting watts lost with the speed. These curves should, of course, be corrected for the resistance loss of the motor armature. In the first test, at any speed, the loss is equal to the frictional losses of the two machines, plus the iron loss in the motor. In the second case we have an additional loss, which is due to the iron in the generator; and by subtracting the first curve from the second a curve for iron loss at any speed of the motor is obtained. Then, by subtracting this curve from the first obtained, the friction losses in the two machines are obtained, which if divided by two give the friction loss of the motor for all speeds. The advantages of this method are that but two tests are required; there is no possibility of error due to differences in the two fields; and by placing a voltmeter across the terminals of the generator the flux in the generator armature may be computed and the relation between this and iron losses be determined. —*Abstracted from the Electrical Review (London), December* 1.

Single-Phase Locomotive Testing.

Some interesting tests were made recently of a single-phase locomotive built by the Westinghouse Electric and Manufacturing Company, a brief résumé of which is given here by Mr. Graham Bright. The locomotive consists of two units, each equipped with three 225-horse-power single-phase railway motors. The two units may be used independently or together, as desired. In this instance they are geared for slow-speed freight service. The two units together weigh 136 tons. During the tests the locomotive was required to draw fifty new steel freight cars. In order to increase the draw-bar pull, the brakes on the four rear cars were set, and at times sand was used. A maximum draw-bar pull of 97,000 pounds was obtained in this way, which gives a friction coefficient of thirty-five per cent. In one test an average draw-bar pull of over 60,000 pounds was obtained for a considerable period of time, with no indication whatever of slipping, although sand was not used. The curves given show a gradual increase in the maximum draw-bar pull, though it is stated that this increase could have been made at a greater rate had it been desired. Dynamometer curves for the tests give some significant figures. In one test the controller was moved around to the full-on position in forty-five seconds. The acceleration for the first forty seconds was one-quarter of a mile per hour per second, which is thought to be very good when the weight of the train is considered. In this case a single unit was employed, weighing only sixty-two and one-half tons. During the steepest part of this acceleration curve the power taken from the line is extraordinarily low. The watt-hour per ton-mile given for the run were only 18.7, which is low for such a high average speed. The controller used with this equipment has nine notches, any one of which gives an efficient running speed. The different notches are obtained by bringing out taps from suitable points on the transformer winding. No starting resistance whatever is used. The line and motor voltage curves became practically constant after the controller reached the full-on position. The curves for current and kilowatts show a gradual decrease as the speed increased and the acceleration decreased.—*Abstracted from the Electric Journal (Pittsburg), December.*

The Illuminating Engineering Society.

The committee on permanent organization appointed at the preliminary meeting looking toward the formation of an illuminating engineering society announces that it will be difficult to make a full report before Wednesday, January 10, 1906. The next meeting will therefore be postponed until that time. The meeting will be held at the Hotel Astor, New York city, at 8 P. M. A table will be reserved in the grill room for those desiring to dine at the hotel on that evening.

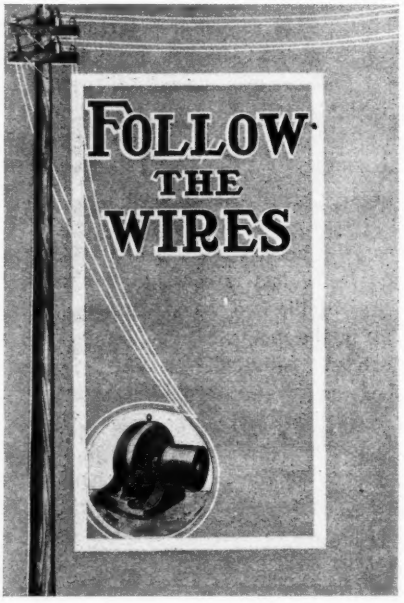
Methods of Getting New Business.

A department devoted to the commercial development of Central Stations. Managers are invited to contribute suggestions for methods of increasing the demand for electric service.

The importance of advertising is coming to be generally appreciated in central station work, but there is one point which has often been overlooked by the managers of the smaller properties which constitute so large a proportion of the total number of plants in this country. This is the very moderate cost of securing effective publicity by simple methods in cases where the company's income does not warrant a campaign on a large scale. Recent visits to numerous small central stations convince one that a great deal of good may be accomplished at a merely nominal expenditure, in the way of keeping the public in touch with the latest electrical developments. The keynote of such work is to make the company's offices a centre of enlightenment, and it is surprising how much can be accomplished by merely using the opportunities incidental to the regular visits of the public for the purpose of paying monthly bills, renewing lamps, or making enquiries in connection with new equipment, repairs, etc.

In the smaller cities and towns the great majority of the customers' bills are paid in person at the offices, instead of by check. It is only necessary for the company to display the latest equipment in a prominent place at the offices to arouse a considerable interest on the part of the public in domestic and commercial application of electricity. The location of the exhibit is worthy of particular emphasis, for in some cases the apparatus displayed has been shown at a great disadvantage in some back room on the premises rather than in or adjoining the front offices. Many a customer will pause for a few moments to examine a new motor, sign, heater or lamp if it is set up in close proximity to the cashier's window where he pays his bill, when the location of the apparatus in an out-of-the-way corner would result in its being entirely passed by. Elaborate displays of equipment are quite unnecessary in such cases, but enough of a variety should be shown to convey the idea of the great range of the central station's usefulness. If the company sends out printed matter now and then it is well to utilize the envelopes which carry the bills for suggestions, thereby saving the cost of extra postage and stationery and yet securing a regular monthly audience with each customer with very little effort. Neat piles of printed matter on the ledge of the cashier's window are likely to be much more effective than when scattered around the premises in a haphazard fashion.

It costs very little to wire up apparatus at the offices for demonstrating purposes. The display of different sized lamps of various kinds, which may be operated at will, with the cost of current per hour tabulated below each one, is a simple but effective method of interesting the public in improvements in illuminating units. Progressive manufacturers are always glad to cooperate with central stations in the supply of representative apparatus for exhibition purposes. A two-minute demonstration of the operation of an electric sign flasher is worth half an hour's verbal description of the device. In such ways as these, without the employment of special solicitors and at a small expense per month, the small central station has an opportunity to do some exceedingly profitable work.



PAMPHLET ISSUED BY THE DENVER GAS AND ELECTRIC COMPANY.

The accompanying illustration shows a reproduction of a cover page of a neat pamphlet issued by the Denver Gas and Electric Company, Denver, Col., a short time ago. The color scheme was in blue, white and sepia, and the pamphlet measured five inches by seven and one-half inches. The story presented a neat conceit in the detailing of the absolute dependence of a busy man upon the electric current from moment to moment throughout the day. This included the services of the electric bell for waking, the water heater for quick shaving, the electric laundry iron for pressing a soiled collar, the chafing-dish for the breakfast, the trolley car to carry the man to work, and the electric light to illuminate the paper, with the electric heater to make the car comfortable. The electric-elevator carries him from the street to the upper floors of the business building, when the telephone comes into service as a means of distributing the engagements. The electric fan keeps the office properly ventilated, with the telegraph ticker bringing the news of the markets of the world into the office. If the day is dark the electric lamp is at hand, and when business is over the electric automobile can be relied upon for a quick, safe trip. Dinner down-town is indicated by the many glittering signs in front of the up-to-date restaurants, while the theatre holds out its invitation in incandescent lamps. After the play the home is made comfortable with the electric heater and the soft diffusion of electric lights, and possibly, just before retiring, the useful chafing-dish comes in for the preparation of a rarebit.

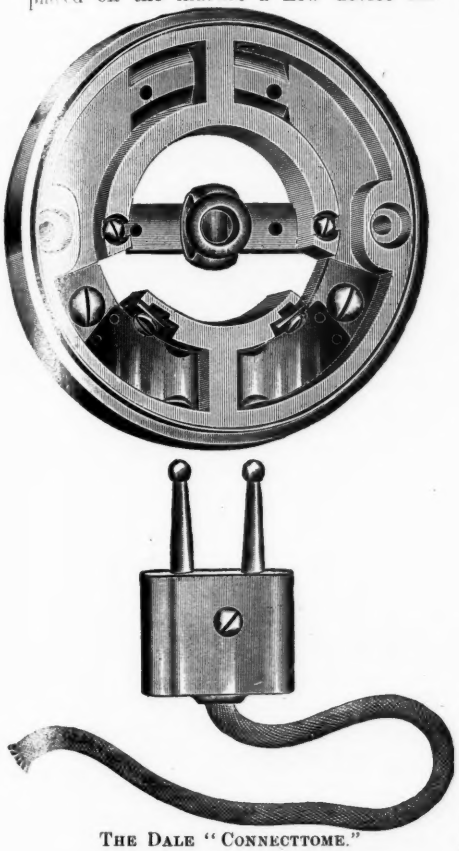
Several of the larger central stations have recently been written-up in the prominent dailies of their respective localities. This is a feature of central station publicity which should not be overlooked. There are so many points of "story" interest in the production of electricity, and there is such a vital curiosity on the part of the average reader as to the developments of this science, that there are many good stories available for the daily press. In the subject of applying electricity to household utilities alone there is material for a write-up, which could not fail to attract a great deal of public attention. If the matter is properly handled and brought to the attention of the editorial forces, it is quite likely that a good deal more legitimate publicity could be obtained than is now the case.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

The Dale "Connecttome."

The Dale Company, Ninth avenue and Thirteenth street, New York city, has placed on the market a new device for



THE DALE "CONNECTTOME."

connecting portables, which has been designated as the "Connecttome" (Connect-to-me). The manufacturer considers that this device will fill a long-felt want for hotels where curling-irons, portable lamps and fan-motors are installed or where their installation may be contemplated. In large office buildings portables are very extensively used in addition to fan-motors. With this device there is obviated the installation of flush receptacles, saving the cost of installing a separate circuit.

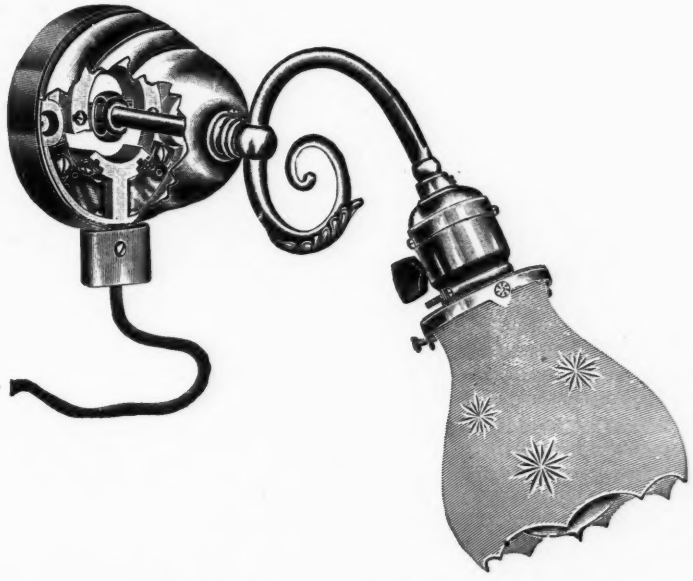
The device can be fastened to the wall or outlet-box, and becomes a part of the fixture when installed. It thus does away with the necessity of soldering, splicing and taping of wires. It may be adapted to straight electric or combination brackets, and is made for single or double connections. The "Connecttome" is neat in appearance and is furnished in any finish.

It will be remembered that during last summer the Dale Company's plant was destroyed by fire. Due to the excellent organization no trace of this now exists and the factory is very busy working up the multitudinous details which go into such a complete line of electrical fixtures as the Dale Company produces.

Advances in Window Lighting.

The National X-Ray Reflector Company, Chicago, Ill., has placed on the market a new form of window reflector, for which several claims of particular merit are made. The principal feature of this reflector is that material may be selected from stock, so that any desired effect may be secured. The reflector, which is illustrated herewith, has been termed a "Poke Bonnet" searchlight. The "Poke Bonnet" reflector is a trough reflector constructed in sections, each fourteen inches in length and complete in itself. These units can be combined to give any desired length required, but the light from each is so great that they may be fitted up at intervals instead of being used as a continuous trough. In this way a saving of one or more lights every three feet can be effected.

The manufacturer claims that these reflectors will about double the light with the same current. Each section being separate and independent, the reflector can be adjusted to any desired angle to throw the rays of light where they are most needed. When used in the window they can be placed in the front, top, back or end. Where only a few are needed, each reflector may be used as a separate lighting fixture, and easily installed.



THE DALE "CONNECTTOME" AND FIXTURE.

While these "Poke Bonnet" reflectors were intended primarily for window lighting, they have met with favor for picture lighting and for the illumination of art displays. Where a considerable number are necessary for a large window or around the sides of an art room, they are attached to one-inch tubing, through which the wires run. This tubing is suspended from the ceiling by chain supports or by a flange on the end attached to the wall.

SECTIONAL UNITS OF "POKE-BONNET" REFLECTOR.

LIGHT DISTRIBUTION FROM A "POKE-BONNET" REFLECTOR.

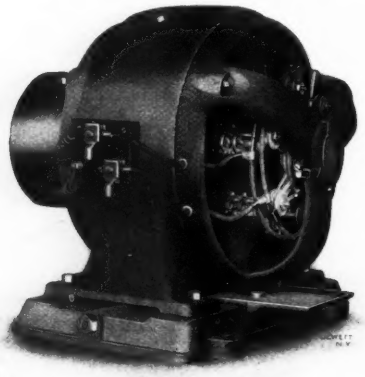
The reflector is made of heavy glass, with a spiral corrugated surface, plated with sterling silver. The sterling silver surface gives, because of its whiteness and brilliancy, a fine reflecting surface, and the spiral corrugations break the rays of light, so that there is no shadow thrown by the filament.

Each "Poke Bonnet" section is furnished with a nickel-plated twin socket,

so that two lamps of any desired candle-power may be used — eight, sixteen or thirty-two—according to the volume of light desired. The back of the reflector is covered with an elastic enamel, which will not crack. The surface of the reflector can be washed without injury.

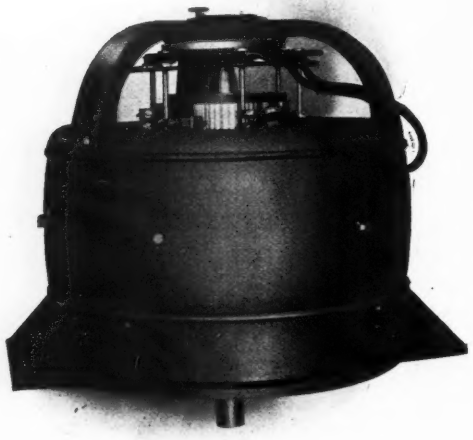
The Development of Sprague Electric Motors.

Any allusion to the extending adaptability of the electric motor drive is at this day considered trite. However, not much more than fifteen years ago the electric motor was very little used. Within



TYPE D MULTIPOLAR MOTOR, OPEN.

that time its development has been so rapid that to-day it is considered an important factor in power economy. One of the names most intimately associated with the development of small direct-current

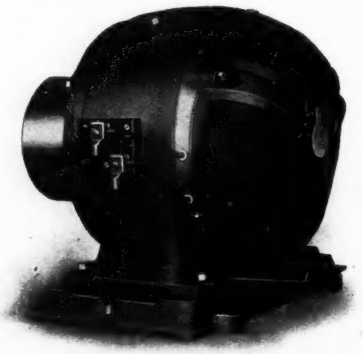


TYPE D MULTIPOLAR VERTICAL MOTOR.

motors is that of the Sprague Electric Company, New York city. The motors made by this company are now used in almost every civilized country.

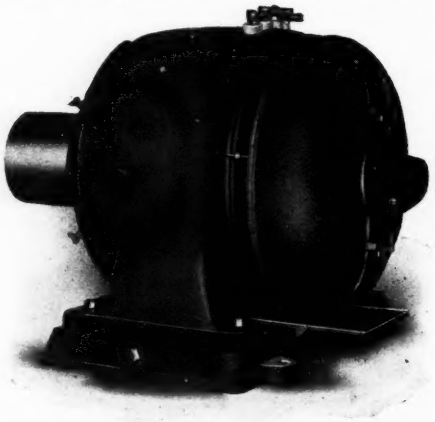
The high efficiency and other qualities of the Sprague electric motors have caused them to be regarded with constantly increasing favor, and they are now used in many of the most prominent industrial and isolated plants.

The bipolar, round-type motors have been long and favorably known. So many



TYPE D MULTIPOLAR MOTOR, SEMI-ENCLOSED.

have been the adaptations of this type of motor that the company has placed on the market a new line representing the latest developments in this style of machine. The accompanying illustrations show several views of type D motors. These new motors range in size from ten horse-power



TYPE D BIPOLAR MOTOR. ENCLOSED.

to 105 horse-power, and they are made open, semi-enclosed and entirely enclosed. The small sizes are bipolar, but from twenty horse-power up the motors are multipolar. In every respect the type D motors fulfil the highest standards of the Sprague electric apparatus.

A New Electric Battery.

The Columbia Battery Company, Milwaukee, Wis., has placed upon the market a new form of storage battery for electric vehicles and electric launches. The company claims that this battery operates with practically no sediment, little danger of sulphatation, and with very little local action. The voltage on discharge is maintained at a high point, and the plates operate without buckling or warping. The company announces the use of an improved electrolyte giving a large amperage. The battery is light in weight, and the company claims over 100 miles on country roads on a single charge.

New Prime Movers.

Two interesting prime movers have been brought to notice recently in England. One of them is a steam turbine invented by Otto Kolb, of Karlsruhe, Germany, who has recently obtained a British patent. This machine is described in the *Mechanical Engineer* (London), December 16. The turbine consists of two wheels, forming the rotor, and an enveloping casing, divided into two chambers. One of these rotor wheels runs between different portions of a winding channel. The steam is admitted through one part of this channel by means of an expanding nozzle, impinges upon the wheel, and, issuing from the far side, is guided by another section of channel so as to pass again through the rotor in the opposite direction. Upon issuing from the far side it is again returned to the rotor. The other part of the rotor is formed of a series of concentric rings of vanes, which alternate with corresponding fixed vanes attached to the housing. This wheel forms the second stage of the turbine. An interesting feature of this turbine is the liquid steam-tight joint which surrounds the shaft. This consists of a number of annular chambers opening outwardly, into which project corresponding rings carried on the shaft. These chambers are filled with water, oil or other suitable fluid. As the turbine shaft revolves this fluid is thrown outward by centrifugal force, and thus forms a hermetical seal between the two chambers of the turbine.

The other prime mover is a method of compounding an internal combustion engine. The system is due to John W. Ottley and Arthur W. Brightmore, both of England. The improvement consists essentially of constructing the engine with two similar cylinders. These are arranged so that they may be operated double-acting, and the cranks are placed in similar angular positions. When an explosion takes place in one cylinder the gas is expanded throughout the stroke. As the end of the stroke is reached an exhaust port opens, which admits the gases to the other end of the cylinder, and at the same time to the corresponding end of the second cylinder. This allows it to be further expanded, at the same time assisting the second cylinder in its compression stroke. At the next stroke the explosion takes place in the second cylinder, and the cycle is repeated. This engine is also described in the journal referred to above.

Improved Condensing Apparatus.

The C. H. Wheeler Condenser and Pump Company, Philadelphia, Pa., has brought out a new "high vacuum" condensing outfit which comprises the improved C. H. Wheeler surface condenser with a Mullan suction valveless air pump. Fig. 1 illustrates the complete outfit, the air pump here shown being steam driven. These pumps are also built in the multi-cylinder vertical-geared type for driving by electric motors, belt or steam.

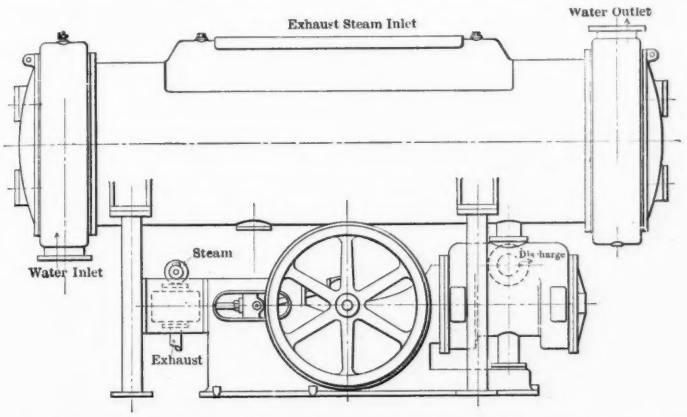


FIG. 1.—ASSEMBLED PROJECTION OF SURFACE CONDENSER AND SUCTION VALVELESS AIR PUMP.

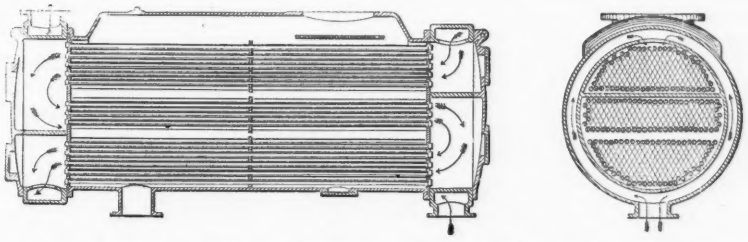


FIG. 2.—SECTION OF SURFACE CONDENSER, SHOWING PATH OF COOLING WATER.

The condenser is of the series-parallel type, as will be evident from the sectional view Fig. 2. The water enters the top group of tubes first, passes thence to the middle section and finally through the bottom section of tubes, connecting-chambers being provided at the ends of the shell, as is clearly shown in the engraving. The maker calls particular attention to the arrangement of water chambers; this arrangement keeps the condenser completely filled with cooling water at all times, the water entering and leaving at the top. The inlet is at the bottom, but the water is carried up through the annular chamber, shown in the cross-section view, and enters the tubes from the top.

The air pump is double-acting and devoid of suction valves. The cylinder has a central port which is uncovered by the piston at each end of the stroke and covered at all other positions; discharge valves of the familiar spring-seated poppet type are located in both heads of the cylinder. As the piston moves from one end of the stroke to the other, it forms a vacuum behind it and forces the gases and water ahead of it out at the discharge valves at the end; when it reaches the end of that stroke the central inlet port is uncovered, and the vacuum behind the piston draws in the condensation and gases from the condenser. This operation is repeated, of course, on the return stroke. (See Fig. 30.)

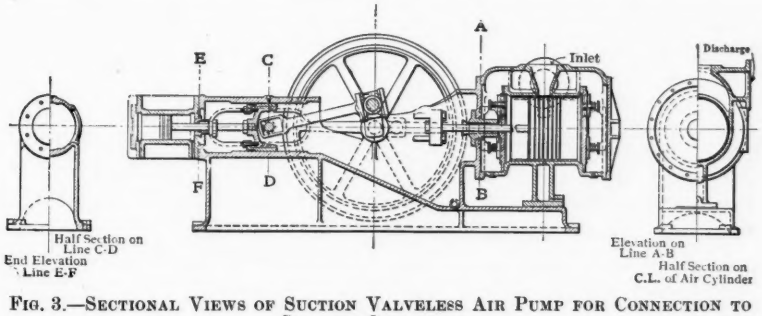


FIG. 3.—SECTIONAL VIEWS OF SUCTION VALVELESS AIR PUMP FOR CONNECTION TO SURFACE CONDENSER.

The maker claims that the pump will separate, under shop-test conditions, within one-half inch of the barometer, enabling a guarantee of a vacuum within two inches of absolute under full-load conditions of steam-turbine operation. Owing to the improved condenser design, the discharge from the pump is within a few degrees of the temperature due to the vacuum in the condenser.

An All-Metal Locker.

Edward Darby & Sons, Incorporated, Philadelphia, Pa., is manufacturing and installing the "Pen-Dar" system of metal lockers. The "Pen-Dar" expanded metal locker, as its name implies, is made of expanded metal by a new process patented under date of April 25, 1905. This metal is made from a sheet of planished steel plate, cut, expanded and then rolled in such a manner that it presents a smooth surface entirely free from rough edges or corners.

AN ALL-METAL LOCKER.

This locker is entirely of open mesh, and allows a free circulation of air, and is therefore thoroughly ventilated and a radical sanitary improvement over the old style clothes closets.

All "Pen-Dar" metal lockers are furnished with one shelf, three nickel-plated coat hooks, individual brass number plates, and a three-point locking device which fastens the door at the top, centre and bottom with one single motion of the locking lever. These locks are supplied with two individual non-changeable keys, numbered to correspond with each locker, and each entire set master-keyed.

They are made in groups of convenient size, or according to requirements, and are finished in Tuscan red, olive green or black enamel.

The value of the metal locker as a clothes receptacle is generally recognized, especially for manufacturing establishments. The open mesh, allowing a free circulation of air, is of decided advantage; and further, the contents of each individual locker may be thoroughly inspected at any time. The individual lockers are also time-savers to a considerable degree, as each occupant knows exactly where the articles of clothing are placed, and there is therefore no unnecessary hunting for mislaid or lost articles.

A New Company for the Manufacture of Dry Batteries and Fan Motors.

Among the many important manufacturing enterprises beginning their existence in the new year, the officers of the Standard Electrical Manufacturing Company, of Niles, Ohio, announce the organization of a new company, the Star Electric Company, to be located in Niles, Ohio. It is the intention to finance this company by the stockholders of the Standard Electrical Manufacturing Company.

Mr. James P. Gilbert, who is secretary of the latter company, will occupy a like position with the new organization. Mr. H. H. Albert, sales manager of the Standard Electrical Manufacturing Company, will also occupy a like position with the Star Electric Company.

It is the intention of the new firm to engage in the manufacture of dry batteries and fan motors. After spending several years in experimenting, Mr. Gilbert has perfected a dry battery which it is claimed will soon command a prominent position in the market. It is announced that with the assemblage of especially high-grade ingredients heretofore unused in work of this kind and the employing of the celebrated Henrion carbon, a battery of exceptionally long life, high amperage and recuperative powers has been perfected. This has been assured by repeated tests. It is intended that two types will be put on the market, one for gas engines and automobiles and the other for telephone and bell work.

The fan motor line will consist of the regular type of direct-current motors. A swivel, swivel and trunnion, and oscillating fan in twelve-inch and sixteen-inch sizes will be marketed.

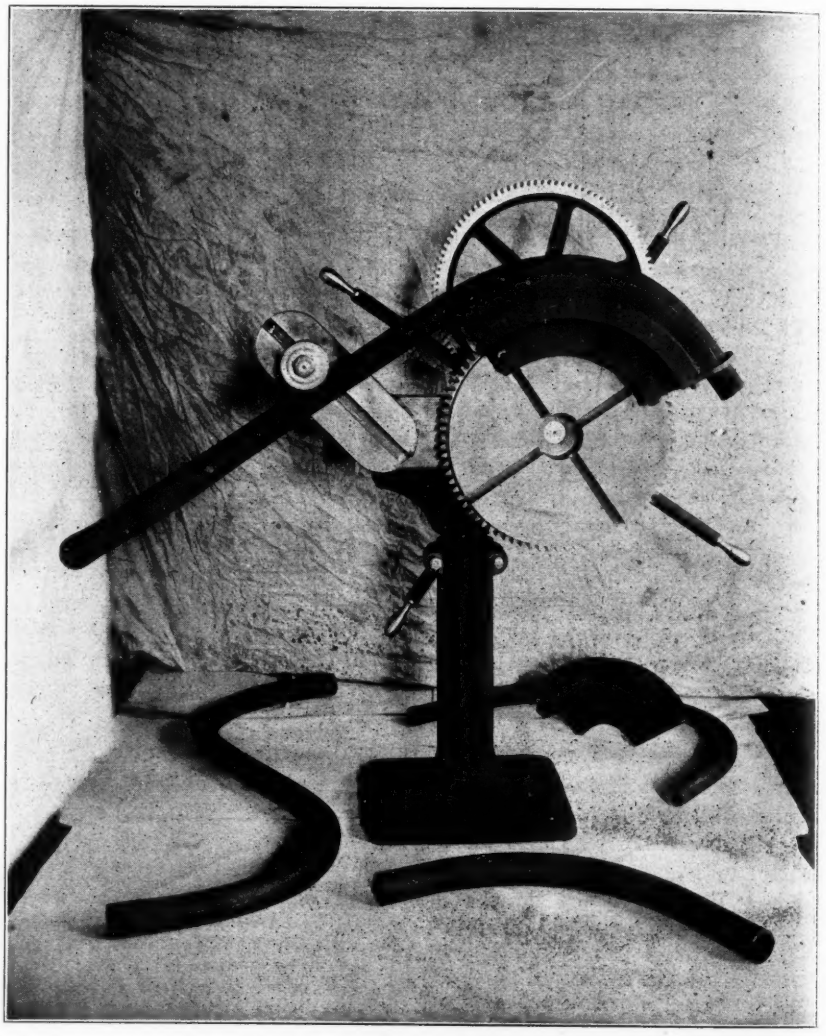
The Pedrick & Smith Pipe-Bending Machine.

The accompanying photograph illustrates a machine recently perfected for bending pipe cold. Piping of steel, iron, brass, copper or other material can be bent cold up to and including two inches in diameter. The machine is adaptable by means of special formers for bending light angles, flats and tee-bars.

The gearing is compound with a ratio of twenty-five to one, thus giving the machine a powerful leverage. A boy can bend two-inch pipe with little effort. The machine is operated by a hand-wheel consisting of four handles which by means of the compound gearing engages the face-plate to which are attached the bending quadrants. The pipe is held in the quadrant at one end by a steel plate, while the resistance stud on the movable arm engages the other end. The various curvatures are obtained by adjusting the arm, which has a swing of three-quarters of a circle, supplemented by the movement of the resistance stud in the "T" slot of arm.

The machine is mounted on a telescopic stand, which can be raised or lowered to any suitable height; when the base is fastened the upper part swivels. A universal arm or section for the stand is furnished so that, if so desired, the face-plate may be placed in a horizontal position at any height from the floor.

Quadrants are furnished with the machine for one-inch pipe with a radius of six inches, for one and one-quarter-inch pipe with a radius of nine inches, for one and one-half-inch pipe with a radius of twelve inches and for two-inch pipe with a radius of fourteen inches. While these four quadrants are furnished with the machine, smaller sizes of pipe can be readily bent in the larger size quadrants very satisfactorily. In fact few workmen will take the time to change the quadrants unless they require a shorter radius than the larger quadrant will give them.



NEW PIPE-BENDING MACHINE.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

PARIS-NICE TELEPHONE LINE—The telephone administration of Paris, France, announced that a direct telephone line from Paris to Nice will be inaugurated the coming season—in January probably. The total cost involved is $200,000.

NEW YORK, WESTCHESTER & BOSTON RAILWAY CONTRACTS LET—T. D. Rhodes, president of the City & County Contract Company, the concern that is building the New York, Westchester & Boston railway, announces that contracts have been let to the Terry & Tench Company for about 4,000 tons of steel bridge work for that portion of the road within the limits of the borough of The Bronx. The work is to be begun at once, and the bridges are to be completed not later than June next. The abutments of a number of these bridges are already in place.

CONSOLIDATION OF COLORADO POWER PLANTS—A consolidation of all the electric lighting and power plants of the Cripple Creek district is shown by a quit-claim deed filed with the county clerk and recorder at Cripple Creek. The deed is given by S. T. Smith, of Denver, to transfer the property to Thomas H. Davis, of Pueblo, who, in turn, makes a transfer of the property to Andrew W. Miller, of Pittsburg, Pa. The deed shows that Mr. Smith turns over all of the property, together with improvements formerly owned by the Gold Belt Consolidated Electric Company, and also makes transfer of various franchises. The deed is understood to involve a valuation of $1,000,000.

HYDROELECTRIC ENTERPRISE FOR CENTRAL CALIFORNIA—The Stanislaus Electric Power Company will undertake the development of a large hydroelectric power plant in Central California. The project includes the erection of a power plant on the middle fork of the Stanislaus river at Sublett's Crossing, about six miles from the town of Murphys, Calaveras county. Storage reservoirs will also be established at the head waters of the river, and there will be a diverting dam near Sand Bar fort in Tuolumne county. A flume and ditch system, fifteen and one-half miles long, with a capacity of 300 cubic feet of water per second, a large equalizing reservoir above the power-house site, a system of pipe lines delivering water to the power-house under a head of 1,500 feet, and a power station equipped with water-wheels and electrical apparatus, with a capacity of 20,000 kilowatts, will be provided. There will also be a transmission system providing for distribution of power to a market within a radius of 150 miles of the power-house.

MEXICAN POWER PLANT TO MAKE EXTENSIONS—Additional bonds to the amount of $2,000,000 will be issued at once by La Electra, the Spanish electric light, power and street railway company, of Guadalajara. The additional bond issue was authorized at a general meeting of the stockholders of the company, held for the purpose of authorizing the bond issue, approving the recent purchase of the Facundo Perez water concession on the Santiago river, and authorizing the purchase of any other water powers that may be thought necessary by the executive committee of the company. So far as is known, no other negotiations, looking to the acquisition of other water powers, are now in progress. The new issue makes a total of $4,000,000. It is estimated that the rebuilding and equipping of the street railway lines at Guadalajara; the construction of a new power-house at Juanacatlan, the machinery for the power-house, and the construction of a central station in Guadalajara will cost nearly $3,000,000. It is probable that the Central and other banks of the city of Mexico, which took the bonds of the first issue, will also take the new bonds.

BELL TELEPHONE COMPANY, OF BUFFALO—By the issue of $1,210,000 of new stock, the Bell Telephone Company, of Buffalo, N. Y., will bring its outstanding capital up to $7,260,000. The authorized capital stock of the company is $10,000,000. So far the cost of construction of the plant has been met by the use of stock at par or out of the earnings, and no bonded debt has been incurred. Increased capital is necessary to take care of the floating debt of $953,339, accumulated to meet heavy expenditures for new equipment rendered necessary by the rapid expansion of the business. The increase in the number of stations outstanding for the eleven months of 1905 amounts to 7,201, or nineteen per cent. The business of the company has increased steadily, and the earnings for the first eleven months compare favorably with those of last year. For the shorter period of this year the gross earnings are rather larger than for the whole of 1904, and the net earnings show equally satisfactory results. The expenses of the company amounted to about sixty per cent of the gross earnings, and after allowance for dividends, $171,993 is appropriated out of the eleven months' earnings to depreciation.

LONG ISLAND RAILROAD IMPROVEMENTS—The Long Island Railroad Company has announced that its $10,000,000 programme of improvements in the borough of Brooklyn, which was started about four years ago, will be completed within fifteeen months. Since the programme began with grade separation in Atlantic avenue, between Atkins and Fifth avenues, the scope of improvement has so broadened and increased that the company says Brooklyn is to have railroad facilities, both freight and passenger, far in excess of what was originally contemplated. Complete plans have been shown by the railroad company. Generally speaking, the improvement programme is in three sections: the Atlantic avenue grade separation, the Bay Ridge grade separation and freight terminal and the Brighton Beach grade separation. The grade separation in Atlantic avenue, which has been accomplished by subway and elevated sections, cost about $2,500,000, of which the city of New York paid half. The electrification, which is eighty-five per cent completed, will cost about $5,000,000 more. The passenger terminal at Flatbush and Atlantic avenues is well under way. A two-story freight house is to be erected in the block bounded by Flatbush and Atlantic avenues and by Hanson place and Fort Greene place. It will have an additional story underground. A large express stable is to be put up on Atlantic avenue between Sixth and Carlton avenues. In connection with the main freight station freight delivery yards are to be established at a dozen points, covering practically the entire borough. The Bay Ridge improvement scheme contemplates a separation of grade between Bay Ridge and the Brooklyn city line. A freight terminal will be erected at Bay Ridge which will cover 790 city lots. It is to be between Sixty-fourth and Sixty-sixth streets west of Fourth avenue. The Brighton Beach improvement contemplates grade separation between Manhattan Beach and Manhattan Beach junction.

TELEPHONE AND TELEGRAPH.

PEORIA, ILL.—The Bell company has completed the building of another through-line from Peoria to Chicago.

JOHNSON, MASS.—A farmers' telephone company has been organized by Winfred Davis, George Butler and others.

JOANNA, PA.—The Conestoga Telephone and Telegraph Company has begun the building of a line from Birdsboro to Stonersville.

PHILADELPHIA, PA.—The new telephone line from Kleinfeltersville to Richmond and Newmanstown is rapidly nearing completion.

PORT DICKINSON, N. Y.—The construction of a new telephone line from Chenango Bridge to Port Dickinson, to connect with the York state line, has been begun.

JAMESTOWN, N. Y.—The Home Telephone Company has elected the following officers: president, Arthur C. Wade; vice-president, William J. Maddox; secretary and treasurer, Thaddeus S. Lane.

WILLIAMSPORT, PA.—The White Deer Telephone Company has completed its lines through Allenwood to Elinsport, and is now connected with the United company's lines entering Watsontown.

DOYLESTOWN, PA.—The Keystone Telephone and Telegraph Com-

pany has begun work installing its system in Doylestown, and expects to have the line working to Philadelphia early in the spring.

MAUCH CHUNK, PA.—The United Telephone Company has leased the Carbon County Telephone line, which runs through the Panther creek valley. W. D. Zehner is superintendent, and A. J. Thomas, secretary, of the Carbon company.

RAYMERTOWN, N. Y.—At the annual meeting of the directors of the Pittstown Telephone Company William B. Cushman was elected president and John B. Cushman secretary and treasurer. A resolution was adopted to build a joint truck line to connect with the Johnsonville Telephone Company.

GREENSBORO, N. C.—The North State Telephone Company, of High Point, has been granted a franchise to open, not exceeding twenty-five, long-distance service booths in Greensboro. The establishing of this long-distance service gives Greensboro direct connection with 1,200 stations of the North State company's lines in the lumber and cotton-mill sections of Randolph, Moore, Montgomery and Davie counties.

TAMPA, FLA.—A merger of local telephone exchanges has been announced whereby the Southern Bell Company abandons the local field; its plant, equipment, business and franchises being acquired by the Peninsular Telephone Company, the independent company, which has been in operation for several years. The consideration has not been made public. The Bell company will retain its long-distance toll line privileges and proposes to establish connection at once between Tampa and Jacksonville.

WILMINGTON, DEL.—The new building of the Delaware & Atlantic Telegraph and Telephone Company, which will include the present building, will have a frontage of 100 feet on Shipley street, an increase of seventy feet, and about the same depth on Sixth street. The building will house all of the departments of the company, some of which have been crowded out of the present building. It will have a capacity for 50,000 connections. The present building was erected seven years ago, at which time the company had 750 telephones in service. In addition to the building the company will continue the extension of its conduit system. It is expected that work will be commenced as soon as possible after the first of the year.

NEW MANUFACTURING AND CONSTRUCTING COMPANIES.

NEW BRUNSWICK, N. J.—The Middlesex Light and Equipment Company has been incorporated by Louis Wolfron, William Schlessinger and William Wolfron.

TRENTON, N. J.—The Essex Light and Equipment Company has been incorporated to manufacture and deal in lighting appliances. The capital stock is $100,000, and the incorporators are E. E. Bruen, Clarence E. Bruen and Ralph F. Ward.

FALL RIVER, MASS.—The International Electric Company has been incorporated with a capital of $50,000, to do a general electric business. The officers are: A. E. Stevens, president; R. F. Haffenreffer, treasurer.

TROY, N. Y.—The Troy Light and Equipment Company, of Troy, has been incorporated with a capital of $10,000. The directors are Edson S. Starks, Karl S. Ferguson, Frank H. Kennedy, Ralph T. Starks and Frederick E. Bowen, all of Troy. The company will deal in gas and electric fixtures.

OLYMPIA, WASH.—The Automatic Despatch and Transit Telegraph Company, of Tacoma, has been incorporated with $5,000,000 capital by Ira A. Town, Charles Kries and A. B. Gillerman. The company is to acquire patent rights and engage in the business of supplying apparatus for handling messages to and from moving trains.

CLARKSBURG, W. VA.—The secretary of state has issued a charter to the Searchlight Electric Sign Company, of Clarksburg, to engage in the business of buying, selling, leasing and exhibiting electric signs. The capital stock is $10,000, and the incorporators are W. A. Keisler and L. N. Loaenser, of Parkersburg; Rose Steadman, S. J. Butters and S. C. Denham, of Clarksburg.

NEW INCORPORATIONS.

AKRON, IOWA—Akron Electric Company. $5,000.

EDINBURG, PA.—Rural Telephone Company. $5,000.

LOUISVILLE, KY.—Chambers Telephone Company. $1,000.

LARAMIE, WYO.—Laramie Light and Power Company. $75,000.

HARRISBURG, PA.—New Albany Light and Heat Company. $5,000.

SALISBURY, PA.—Citizens' Light, Heat and Power Company. $10,000.

BENTON HARBOR, MICH.—Suburban Light and Power Company. $1,000.

AUSTIN, TEX.—Houston Electric Company. Increased from $2,500,000 to $3,000,000.

GUTHRIE, OKLA.—Independent Telephone Company, of Cestos. $25,000. Incorporators: J. W. Kerns, F. C. Hoyt and H. A. Seaton.

MADISON, WIS.—Brillion Electric Light Company, Brillion. $20,000. Incorporators: C. W. Behnke, A. C. Behnke and I. F. Behnke.

COLUMBUS, OHIO—The Acme Electric Company. $10,000. Incorporators: F. R. Watts, J. H. Watts, William Mellie, J. D. Pelton and A. J. Chesbro.

SPRINGFIELD, ILL.—Quincy Long-Distance Telephone Company, Quincy. $2,000. Incorporators: Frank J. Penick, J. R. Pearce and Samuel F. Scott.

GUTHRIE, OKLA.—Southwestern Transit Company, of Guthrie. $35,000. Incorporators: Ernest R. Ames, of Prague; Shirley A. Bradish and Thomas J. Lowe, of Guthrie.

AUGUSTA, ME.—Jacksonville Railway and Light Company. To operate railways, etc. $500,000. President, G. F. Duncan; treasurer and clerk, E. Woodman, both of Portland.

JEFFERSON CITY, MO.—Marceline Electric Light Company, of Marceline. $20,000, all paid. Incorporators: George W. Early, William F. Callahan and Henry B. Early.

LOS ANGELES, CAL.—Mutual Electric Company, of Los Angeles. $75,000. Directors: F. J. Steele, J. O. Horton, J. E. Moore, J. T. Boyd, A. W. Ellington, all of Los Angeles.

LITTLE ROCK, ARK.—Block Springs Telephone Company. $5,000. Incorporators: W. C. Rowton, C. C. Welch, W. W. Philpot, J. D. Robins, J. A. Abernathy, J. A. Reece, L. B. Bates and G. Cox.

HAMMONDSPORT, N. Y.—Pleasant Valley Telephone Company. $5,000. Officers: president, J. W. Brundage; vice-president, William Dildine; secretary, Pierre Brundage; treasurer, James H. Smellie.

COLUMBUS, OHIO—The Western Ohio Telegraph and Telephone Company, with headquarters at Toledo. $100,000. Incorporators: John Meilink, A. C. Stevenson, F. E. Palmer, J. W. Davis, Joshua Lindall.

PORTLAND, ME.—Portland & Brunswick Extension Railway. To construct a line from Yarmouth to Falmouth, a distance of twelve miles. $48,000. Directors: E. J. Lawrence, A. B. Page, S. A. Nye and Amos Gerald, of Fairfield, and Cyrus W. Davis, of Waterville.

TRENTON, N. J.—Lexington & Interurban Railways Company. For the purpose of constructing urban and interurban railways, and to establish an electric-lighting plant. $4,000,000. Incorporators: John A. MacPeak, F. R. Hansell and George H. B. Martin, all of Camden, N. J.

GUTHRIE, OKLA.—Hopeton Telephone Company, of Hopeton. $10,000. Incorporators: W. H. Davis, R. Z. Linney and J. M. Rambo, of Hopeton; N. A. Andrews, J. C. Zacher, B. Gordon and E. L. Gately, of Dacoma; W. C. Hendricks, of Alva; and J. E. Fuqua and J. J. Duck, of Avard.

SEATTLE, WASH.—Seattle-Issaquah Traction and Coal Company. To build and operate an interurban electric railway between Renton and the towns to the northward in the general direction of Everett. $3,500,000. Incorporators: W. H. Goldson, P. J. Farley, John McQuade, Edwin S. Gill, J. A. Siderberg, C. A. Carlson and Otto Stendahl.

PERSONAL MENTION.

MR. FRANK B. KNIGHT, of Dallas, Tex., who has been prominent for a long time in telephone development, has suffered a sad bereavement in the loss of his wife, who died suddenly on the morning of January 1 at Dallas, Tex. Mr. Knight was for a long time interested in the Bell Telephone Company, and at present is a prominent official of the Southwestern Telegraph and Telephone Company.

MR. W. G. WILLIAMS, for several years representing the Nernst Lamp Company in Pennsylvania and western territory, and previously connected with the Manhattan Electrical Supply Company, of New York city, has accepted a position with the Columbia Incandescent Lamp Company, St. Louis, Mo. He will be connected with the New York and Philadelphia branch offices of the company, covering northern Pennsylvania and New York state.

MR. VINTON A. SEARS, Boston, Mass., who, some months ago, resigned from the automatic telephone companies in Massachusetts, has moved to the Sears Building, Boston, where he will continue to be interested in independent telephone work and securities. He will, however, be independent of any particular system of telephony. Mr. Sears organized the automatic telephone companies at New Bedford and Fall River, Mass. He is the author of the well-known book entitled "Telephone Development, Scope and Effect of Competition," which has gone into a second edition.

MR. A. EUGENE MICHEL has joined forces with the George H. Gibson Company, New York city, having resigned as assistant advertising manager of the Standard Paint Company. Mr. Michel is a graduate of Rose Polytechnic Institute, and was for two years in the engineering department of the Diamond chain works of the Federal Manufacturing Company. He was also in charge of the testing department of the Ewart Manufacturing Company, and was assistant manager of the department of publicity of the International Steam Pump Company under Mr. Gibson. With the accession of Mr. Michel the staff of writers of the George H. Gibson Company includes three engineers who have had extensive practical experience in civil, mechanical, electrical and mining engineering and engineering journalism.

OBITUARY NOTICE.

MR. CHARLES TYSON YERKES, the prominent street railway magnate and head of the London (England) underground system, died on the afternoon of Friday, December 29, at the Waldorf-Astoria, New York city, from a complication of kidney disease and heart trouble. Charles T. Yerkes was born in Philadelphia, Pa., June 25, 1837. His father's ancestors were among the early Dutch settlers, and arrived in Pennsylvania before the Penn colony. His mother was English. After leaving high school Mr. Yerkes worked in the commission house of James P. Perot & Brother. His career as a financier dated from 1859, when he became a stock broker and joined the Philadelphia stock exchange. He was at the head of the dealers in state and municipal securities, and in 1865 worked out a scheme to help the city's credit, by which the bonds, which had been selling for about sixty-five, went to par. As a return for this the city deposited large amounts of its funds with him. In 1871 he was caught in the panic following the Chicago fire, and at that time the city of Philadelphia called upon Mr. Yerkes for its funds. In the failure he lost all of his money, but very shortly made another fortune on the exchange. About this time he took a great interest in Philadelphia railroad stocks, improving the properties and consolidating roads. He failed again in 1871 and his railway stocks were wiped out. He subsequently went West, and after having established a bank in Chicago, he became interested in Chicago tractions. He consolidated several roads into the Union Traction Company, and was instrumental in the development of the Union loop. In 1894 he secured control of the Lake Street Elevated. In 1901 he sold out his holdings to an eastern syndicate, and with a fortune estimated at about $15,000,000 he came to New York city and worked out plans to control the underground railroads of London. In London he formed the Metropolitan District Electric Traction Company, Limited, with a capital of $5,000,000, and the Charing Cross, Euston & Hampstead Railway. The group of capitalists he represented also secured the Baker Street & Waterloo Railway, the Great Northern & Strand Railway, the Piccadilly & Brompton Railway, and the Edgware & Hampstead Railway. On April 9, 1902, the Underground Electric Railway Company, of London, Limited, with $5,000,000 capital, was registered, and it took over the traction company. Mr. Yerkes became chairman, and controlled in this way the entire London underground system.

ELECTRICAL SECURITIES.

In the face of a stringent call for money, which sent the rate up to 125 per cent at one time—the highest since December, 1899—the bull campaign developed further strength and greater activity. The week's speculation, according to the best authorities, in the face of such high money rates, is without precedent in this country's speculative history. A striking feature of the present stock market is that it reached its highest average level during the past week, and closed the year only slightly below the highest on record. A number of these stocks attained new high prices, and that this was more or less genuine speculation is evidenced by the fact that there were five million-share days during the week. The metal markets still continue to reflect unprecedented prosperity, and from every quarter there comes reports that augur well for a very prosperous spring.

ELECTRICAL SECURITIES FOR THE WEEK ENDING DECEMBER 30, 1905.

New York:	*Closing.*
Brooklyn Rapid Transit	88⅝
Consolidated Gas	181
General Electric	177
Interborough Rapid Transit	235
Kings County Electric	200
Manhattan Elevated	162¼
Metropolitan Street Railway	125
New York & New Jersey Telephone	156
Westinghouse Manufacturing Company	190

The directors of the New York & New Jersey Telephone Company have declared the regular quarterly dividend of 1½ per cent and 1 per cent extra. The 1 per cent extra is usual at this time of the year. The dividend is payable January 15 to stockholders of record January 5.

The income statement of the Brooklyn Rapid Transit system for the five months, ending November 30, 1905, is as follows: gross, $7,829,449; operating expenses, $4,138,487; net, $3,690,962; other income, $84,108, a total of $3,775,070; charges and taxes, $2,264,772; net income, $1,510,298; special appropriation, $257,222, leaving a surplus of $1,253,076, as compared with $527,148 for the same period of 1904, an increase of $725,928.

The state commission of gas and electricity has authorized the Kings County Electric Light and Power Company to increase its capital stock from $5,000,000 to $8,200,000. The company made application for leave to increase the capital stock to $10,000,000, giving as the reason for the increase that it desired additional capital for recent and future extensions. The state commission holds that the increase of $3,200,000 will be sufficient.

Boston:	*Closing.*
American Telephone and Telegraph	137
Edison Electric Illuminating	243
Massachusetts Electric	59
New England Telephone	131½
Western Telephone and Telegraph preferred	91

The gross earnings of the Boston elevated system for the year ended September 30 show a gain over those of the previous year of only 2.4 per cent, which is much below the normal percentage of gain shown in previous years. The increase in the gross was $298,323. For the year the gross earnings were $12,689,676, and the expenses $8,617,653, leaving net earnings of $4,123,916.

Philadelphia:	*Closing.*
Electric Company of America	11
Electric Storage Battery common	79¾
Electric Storage Battery preferred	79¾
Philadelphia Electric	8⅝
Philadelphia Rapid Transit	30½
United Gas Improvement	93⅞
Chicago Telephone	138

Chicago:	*Closing.*
Chicago Edison Light	160
Metropolitan Elevated preferred	69¾
National Carbon common	80
National Carbon preferred	117
Union Traction common	12⅜
Union Traction preferred	40

ELECTRIC RAILWAYS.

BRUNSWICK, GA.—Work on Brunswick's electric car line has been commenced.

WASHINGTON, N. J.—Trolley service is promised between Washington and Easton by April.

AUSTIN, TEX.—The preliminary survey for the proposed electric railway, to be built between Austin and Lockhart, has been completed.

MONTGOMERY, ALA.—The Montgomery Traction Company has increased its capital stock from $1,000,000 to $2,000,000 on account of the recent purchase of the Montgomery street railway system.

OAKLAND, CAL.—A new electric railroad project has been broached in Oakland for a line to operate between Berkeley and San Jose *via* Oakland, San Leandro and other localities in Alameda county.

JEFFERSONVILLE, IND.—The Louisville & Southern Indiana Traction Company has bought the plant, power-house, car barns, track and entire equipment of the Jeffersonville Street Railway Company from Captain J. Hamilton Duffy.

EASTON, MD.—There is renewed talk of a railroad to be built from Easton to Trappe and thence south to the Choptank, where connection is to be made with Cambridge. The proposition is to build a trolley line, using the public highway.

SHAMOKIN, PA.—The work of laying a trolley line between Shamokin and Sunbury has been begun by the Shamokin Extension Company, composed of the Hon. M. H. Kulp and New York and Philadelphia capitalists. The company is capitalized at $1,200,000.

BAY CITY, MICH.—The Detroit-Bay City Traction Company's engineers have begun the final survey of the line of the proposed road between Akron and Caro. This survey will complete the work up to the grading point. Between Akron and Caro, however, no grading will be done until the spring.

BURLINGTON, VT.—Plans are under way for the construction of a railway from the line of the Rutland road to the marble quarries in Danby, recently purchased by the Vermont Marble Company. The company will erect a power station on Mount Tabor with which to generate electricity to operate the machinery in the quarries.

DES MOINES, IOWA—The Indianola Interurban Railway Company, capitalized by Des Moines financiers and represented by William Wilcoxen, of Des Moines, has been granted a franchise for an interurban line at Indianola by the town council. The council called a special election for January 30, when the question will be voted upon by the people.

DENVER, COL.—William G. Evans, president of the Denver City Tramway Company, has announced that the company will expend $3,000,000 in improvements, which will include the extension of the line from Englewood to Fort Logan and Littleton, the extension of the Sixteenth street viaduct to avoid the North Denver hill, together with several other extensions.

ADRIAN, MICH.—It is announced that the Toledo & Michigan road has been financed in New York. It is proposed to build this road west from Adrian to Coldwater. The right of way has been secured for twenty miles from Adrian, and much of the grading has been done. Construction work will be resumed in the spring. It is the intention ultimately to extend to Elkhart, Ind.

CHARLESTON, ILL.—The Coles county board of supervisors has granted a franchise to the Charleston Railroad Company to construct and operate a line of electric railway along any of the public highways leading to the southeast, as far as either the Clark or Cumberland county border. One of three routes will be selected. This action relieves the company of the necessity of securing the right of way from the farmers along the route.

MICHIGAN CITY, IND.—It is announced that negotiations for the sale of the Michigan City street car system, which have been pending for several months, were consummated at a meeting of the directors of the Michigan City Electric Company held at Indianapolis. The line becomes the property of the Northern Indiana Railway Company, and the sale includes tracks, trolleys, franchises and the entire rolling stock of the company. The price paid was $200,000.

CINCINNATI, OHIO—Announcement has been made that the Dolan-Morgan-Schoepf syndicate, of Philadelphia and Cincinnati, has acquired possession by purchase of the Zanesville, Ohio, Railway, Light and Power Company. The deal involves at least $1,000,000, and will fill up another gap existing in the system, which the syndicate intends to make complete throughout Ohio. Officers have been chosen as follows: F. A. Durban, president; W. Kesley Schoepf, vice-president; F. A. Daverall, secretary and treasurer.

LAPORTE, IND.—The Chicago, Lake Shore & South Bend Railway Company, promoted by Edwin Hanna and other Cleveland men, has announced the letting of a contract to the John R. Lee Construction Company, of New York, for building an interurban electric line from South Bend through Laporte, to connect with that part of the road between Indiana Harbor and South Chicago, already in operation. Entrance to Chicago, it is asserted, will be obtained over Illinois Central tracks from Kensington to Randolph. The capital stock has been increased to $6,000,000, and a $3,000,000 bond issue has been floated.

LANSING, MICH.—It is announced that the syndicate, composed of James R. Elliott, of Lansing, and Myron W. Mills and George T. Moore, of Port Huron, has purchased a controlling interest in the Battle Creek-Kalamazoo Interurban Trolley Line, and the Battle Creek and Kalamazoo city electric lines. This gives the Mills-Moore-Elliott syndicate control of 193 miles of city and interurban lines in the interior of the state. The lines now held, together with a number of projected extensions, are to be reorganized under the name Michigan United Railways Company, and Lansing will be the centre of the new system.

MEMPHIS, TENN.—The Memphis Street Railway Company has completed reorganization. John H. Watkins, vice-president of the Bank of Commerce and Trust Company, has been elected vice-president. The following directors have been added: W. B. Mallory, Dr. W. B. Rogers and Joseph H. Thompson, of Nashville, Tenn. Other directors are: John H. Watkins, John R. Pepper, president of the Tennessee Trust Company, and T. H. Tutwiler, general manager of the property. A new generator and numerous additional feeder wires will be installed as rapidly as possible with a view to meeting the demands of the larger service now being arranged. Additional car barns, too, are being constructed and the company is disposing rapidly of the old cars, substituting more moderate ones therefor.

PITTSBURG, PA.—Street car companies organized and controlled by Pittsburg capitalists are beginning the construction of roads through Washington county. The project includes the connection of all the towns along the Monongahela river with Washington, Pa. The companies are to be known as the Coal Center Electric Company, the West Middletown Electric Railway Company, the Washington & Brownsville Street Railway Company and the Washington & Independence Street Railway Company. The incorporators are: C. H. Robinsteen and G. M. Neagley, of Pittsburg; H. H. McClure and W. H. Armstrong, of Washington, and D. B. Neagley, of Bellevue. The lines are capitalized at $12,000 each. This will be increased. Surveys are being made and, when they are completed, work of construction will begin.

ST. LOUIS, MO.—Surveys are being completed for a railroad line, to be operated by electricity, between St. Louis and Richwoods, Washington county, Mo. The new enterprise is to be known as the St. Louis, Hillsboro & Southern Railway Company. Its capital stock is $1,250,000. R. E. Williams, president of the St. Louis Compressed Air Housecleaning Company, heads the list of officers. Dr. H. D. Brandt, of St. Louis, is secretary; J. H. Weiner, of Moss Hill, Mo., assistant secretary, and L. D. Winter, treasurer of the American Indemnity Company, is the treasurer. The operating department will be in charge of H. M. Bowen, of Alton, Ill., whose title is that of general manager. The capital stock of the company has been fully paid up, and the officers constitute the board of directors and the chief stockholders. Work on the line will probably begin March 1, and it will cost, including equipment, about $15,000 per mile. The road will traverse the following towns, none of which has ever enjoyed railroad connections: Carondelet, Telegraph Road, Bobring, Lemay Ferry, Luxemborg, Butler's Lake, Burnesville, Regina, Morse Mill, Hillsboro and Richwoods.

ELECTRIC LIGHTING.

WALKERTON, IND.—Walkerton has voted to install electric lights.

MILLERSBURG, IOWA—An electric light plant will be installed at Millersburg.

EDWARDSVILLE, ILL.—The new electric plant at Leclaire has been completed.

DRESDEN, TENN.—A movement is on foot to start an electric light plant in Dresden.

SOUTH PITTSBURG, TENN.—South Pittsburg has voted to buy the electric light plant.

CLINTON, N. Y.—The Oriskany Valley Electric Company has been granted a franchise in the town of Kirkland.

ALTON, ILL.—The Upper Alton village officials are considering a plan to build a municipal electric light plant.

ROGERS, ARK.—Arrangements for the installation of an electric light plant at Pocahontas are said to have been completed.

MUSKEGON, MICH.—The old electric lighting plant owned by the Muskegon Traction and Lighting Company is being remodeled.

TORRINGTON, CT.—It is understood that the Torrington Electric Company is shortly to build an addition to its plant on East Branch street.

DIXON, ILL.—P. C. Higgins, president of the Dixon Power and Lighting Company, has bought the water power and real estate of the Stewart Press Company.

OSWEGO, N. Y.—John C. Knight, manager of the Citizens' Electric Light Company, announces that the new company will be in operation by May 15 next.

XENIA, OHIO—The Xenia Shoe Manufacturing Company has been granted a franchise for twenty-five years to furnish electric current for light and power in Xenia.

WELEETKA, I. T.—The Weleetka Light and Power Company has decided to expend a large sum of money in improving this plant, and until the work is finished the city will be in darkness.

SYRACUSE, N. Y.—The Syracuse Lighting Company has installed six new boilers in its plant. The cost is said to have been $31,000. Preparations are being made to install additional boilers in six months.

OTTUMWA, IOWA—H. M. Byllesby & Company, of Chicago, has purchased the stock of the Ottumwa Traction and Light Company, and will make extensions and improvements. Formerly the stock was owned locally.

TORONTO, ONT.—The contracts for civic electric and gas lighting have been awarded to the Toronto Electric Light Company. The city has been paying $74.825 per light per year, and under the new arrangements pays $63.64

HUNTINGDON, TENN.—The town of Trezevant is agitating the question of putting in an electric light and waterworks plant at an early date, and the business men of the town are organizing a company with this end in view.

CARLISLE, PA.—The Philadelphia & Reading Railroad Company is preparing to provide its own electricity for the lighting of its offices and yards in Harrisburg and the lower end of the county. The plant will be located at Rutherford.

PHILADELPHIA, PA.—The Philadelphia Electric Company has been awarded the contract for street lighting for 1906 by the Philadelphia department of public safety. The amount is $1,073,271.55, as compared with $1,035,508 spent during 1905.

PITTSBURG, PA.—The Homestead council has awarded the contract for the lighting of the streets of the borough to the Allegheny County Light Company for one year, during which time the borough will go into the matter of building a municipal light plant.

RITZVILLE, WASH.—The electric light and power plant owned by the Pioneer State Bank has been sold to a Seattle company. The company will expend $30,000 on a new building and machinery, and expects to furnish power to run the mill in the near future.

BLOOMSBURG, PA.—At a special meeting of the Bloomsburg council the contract for lighting the streets for five years was awarded to the Irondale Electric Light Company at its bid of $3.90 for arc and $1 for thirty-two-candle-power incandescent lights per month.

SALEM, ORE.—The Citizens' Light and Traction Company, which owns the electric light, street railway and gas plants in Salem, has bought out the Union Light and Power Company, which owns an electric plant near Silverton, and supplies electricity to Silverton, Woodburn, Mount Angel, Gervais and Salem.

SUPERIOR, WIS.—The Superior Water, Light and Power Company at its annual meeting at the company's offices elected the following officers: president, Kenneth Clark, of St. Paul; vice-president and treasurer, V. M. Watkins, of St. Paul; secretary, W. H. Winslow, of Superior; general manager, B. F. Ellison, of Superior.

NIAGARA FALLS, N. Y.—A deal has been completed whereby the Niagara, Lockport & Ontario Power Company gets possession of the last pieces of property in Monroe county needed for the erection of the transmission line from Niagara Falls to Henrietta, where the company's right-of-way joins that of the West Shore Railroad.

PEORIA, ILL.—The McKinley syndicate has bought the Edwardsville Light, Heat and Power plant and has incorporated the company with a capital stock of $5,000. The incorporators are: Charles Zilly, B. E. Bramble and George C. Mathis, officers of the McKinley Interurban Syndicate. The plant will in the future be operated by the McKinley interests.

HUNTINGDON, PA.—The borough of Huntingdon is to have cheaper street lighting beginning with July 1, 1907, and extending for a period of six years. At a meeting of the borough council the bid of the Huntingdon Gas Company was accepted. It was for sixty lamps of 2,000 candle-power, to burn all night, at the rate of $41.55 per lamp per year.

DEXTER, ME.—N. Curtis Fletcher has purchased a lot of land, to be used as the site for a new power-house, which is to be built at once to furnish power for operating the electric lights of Dexter. Plans for the plant will be drawn at once and submitted to local contractors for construction bids. It is expected that the plant will be in operation by the first of March.

ST. AUGUSTINE, FLA.—Negotiations have been closed between the Osmand company and the Gas company whereby the former will take over the latter's light plant on a two-year lease, with the privilege of purchasing it at the expiration of that time. It is the purpose of the Osmond people to increase the capacity of the plant, and to have the city lighted electrically at an early date.

ACKLEY, IOWA—Steps are being taken looking to the acquirement of the electric light and heating plant by the municipality. The plant is valued at $20,000, and up to this time has been operated by private persons. It recently changed hands, and it is understood that a proposition viewed by the city with favor has been made and will be considered with a strong possibility of a purchase being effected.

READING, PA.—An electric light plant is to be erected along the Schuylkill at Birdsboro. The machinery will be generated by water power, which will be drawn from the canal. The plant is to be erected by the E. & G. Brooke Iron Company, and will be located near the aqueduct. This will be the third electric plant along the Schuylkill. The first to be built was the one at Klapperthal, and the second was constructed along the west side of the Schuylkill, above Phœnixville.

SALT LAKE CITY, UTAH—Lucien L. Nunn, of Provo, Utah, has made application for the appropriation of 1,540 acre-feet of water, to be taken from the Lake creek fork of the Beaver river for power purposes. The application calls for the flood, surplus and unappropriated waters of the Lake creek fork. The water is to be impounded in the Three Creeks reservoir, which has an area of 49.7 acres, and carried 23,529 feet in a wooden flume four feet square to the reservoir. From the reservoir a pipe line is to be laid, carrying the water 3,660 feet to the point where the power plant is to be erected. Two ninety-six-inch Pelton wheels are to be installed and will be operated under a head of 1,625 feet. The capacity of the plant will be 5,250 horse-power. The power generated will be used by the Newhouse Mines and Smelting Company and other mining companies in that locality for electric lighting and industrial purposes.

INDUSTRIAL ITEMS.

THE POPE MANUFACTURING COMPANY, Hartford, Ct., is distributing to some of its patrons a handy calendar pad for 1906.

THE PITTSBURGH TRANSFORMER COMPANY, Pittsburgh, Pa., has issued its calendar for January. Along with this the company is distributing an instruction book and bulletin describing the 1906 thawing-transformer.

THE DEVEAU TELEPHONE MANUFACTURING COMPANY, New York city, manufacturer of standard telephone apparatus, will have an exhibit at the Chicago (Ill.) electrical show, to be held at the Coliseum in that city, January 15-27.

THE DIRECT UNITED STATES CABLE COMPANY, 60 New street, New York city, is distributing the customary calendar pad for 1906. The company has offices in America in New York and Boston, and the foreign offices are located in Halifax, Nova Scotia, and in London, Liverpool, Glasgow and Bristol, Great Britain.

THE WORCESTER ELECTRIC MANUFACTURING COMPANY, 42 Lagrange street, Worcester, Mass., is distributing to its clients a beautiful calendar for 1906. The reproduction is from an original painting by Albert Lynch, and is entitled "Adele." The Worcester company manufactures knife switches, switchboards, panelboards and other specialties.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., is distributing bulletin No. 1202, descriptive of the "Reliance" friction clutch. This clutch has been designed for heavy work, with particular regard to simplicity, durability and ease of adjustment. It is of the disc type, in which a cast-iron disc is clamped between two continuous wood surfaces. There are no springs used in the mechanism, the pressure on the friction surfaces being set according to the load the clutch has to carry, by means of adjusting nuts on the eye-bolts.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., is distributing a card calendar for January, February and March. This calendar bears an illustration of an alternating-current machine, the manufacture of which the Crocker-Wheeler Company took up during the year 1905. After seventeen years' experience in the direct-current field the company entered the market with a complete line of alternating-current generators, motors, transformers, etc. The company now occupies a prominent place in the field, supplying both direct-current and alternating-current apparatus.

THE WESCO SUPPLY COMPANY, St. Louis, Mo., the sponsor of the Live Wire Publishing Company, calls attention to an article in the December issue of "The Live Wire," suggesting the desirability of lighting companies having printed data concerning their plants on their letterheads. This information is with regard to the system—whether direct or alternating current; the primary and secondary voltage, if alternating; the phase and circuit; the character of service, and the type of incandescent lamp base in use. The point is made that if central stations adopt this plan it would be of mutual advantge to the purchaser and his supply house.

THE ERNST WIENER COMPANY, New York city, has published catalogue No. 50, covering specialties in railway materials for all industries. This material includes portable, industrial and permanent tracks, industrial track layouts, switches, frogs and crossings, turntables and transfer cars, steel and wooden cars of every description for all industrial purposes, cableways for quarries, brickyards and similar purposes. The book is designed not only to cover industrial railway and allied subjects, but contains tables and other data which should prove of interest to engineers, shop superintendents, contractors and others who may be interested in this class of material. The company's works are at Youngstown, Ohio, and the yards are at Hoboken, N. J.

THE GREEN FUEL ECONOMIZER COMPANY, Matteawan, N. Y., is distributing a booklet descriptive of fans, blowers and exhausters for heating and ventilating, for mechanical draught and other purposes. The company has for many years installed fans and exhausters for mechanical draught in connection with the Green fuel economizer. The company does not contract for the engineering of plants nor for the installation of heating and ventilating plants in competition with heating and ventilating contractors. It has recently added large shops at its plants at Matteawan to handle this branch of the business. A new catalogue, which the company has recently issued, describes and illustrates in detail the Green air heater. This recovers the waste heat for heating and drying.

I. P. FRINK, 551 Pearl street, New York city, is calling attention to the availability of the Frink patent window reflector. This reflector is designed on thoroughly scientific lines. It is built of metal and lined with silver-plated corrugated glass. It is placed at the top of the window near the front glass, and serves to hide the lamps from the sidewalk, at the same time brilliantly illuminating the interior of the window. The Frink reflectors have been installed in hundreds of leading stores throughout the country. Many architects and engineers have found this reflector to be a solution of vexing problems in this class of work. The manufacturer claims that a Frink reflector burns just enough lamps to show up the window display without adding to a store's expense for lighting the street. The reflecting angles are carefully worked out, so that the entire illumination from the lamps is confined within the window.

THE STANDARD UNDERGROUND CABLE COMPANY, Pittsburg, Pa., has leased the exclusive use of an all-copper line to connect its general offices and factories at Pittsburg, branch offices at New York and Philadelphia, and its eastern factories at Perth Amboy, N. J. This private line will be available for either telephone or telegraph service. There could be no better evidence of the large volume of business and the growing condition of this important manufacturing company. This, so far as is known, will be one of the longest exclusive wires owned or operated by any company confining itself to the manufacture of copper wires and cables. The service went into effect January 1, and without doubt will be of the greatest convenience and value to the company in facilitating communication. It is installed primarily, however, to enable it to place itself in closer touch with its customers, affording them the service that would be possible if its general offices were located in each important city instead of in one.

THE ABNER DOBLE COMPANY, San Francisco, Cal., has published a new catalogue entitled "Doble Tangential Water-Wheels." This is the first comprehensive work relating to the Doble company's hydraulic products which has been issued. The first portion of the catalogue contains general matter descriptive of the essential features and parts entering into the construction of Doble tangential water-wheels, special attention being paid to the Doble needle-regulating nozzles, ellipsodial buckets, ring-oiling bearings, nickel-steel shafts, etc. Illustrations of several different types of water-wheels manufactured by the company are followed by descriptions of some of the typical hydroelectric water-power plants in which these water-wheels are now operating. Descriptions of the 8,000-horse-power wheels, which have been constructed for the de Sabla and Electra power-houses, and the 9,000-horse-power wheel, now building, are of interest. The Mill Creek No. 3 plant is noteworthy for the very high head, and the Corneli plant is of interest because of the high efficiency—84.5 per cent—obtained on the Doble wheels. The latter portion of the book contains descriptions of Doble water-wheels, covering all conditions of water power up to a head of 2,500 feet, and in capacities up to 5,000 horse-power. Other tables relate to the loss of head in pipes by friction, riveted steel construction, etc. Four pages are given up to useful hydraulic information. The last seven pages are devoted to a series of ready conversion factors. This catalogue, which is designated as bulletin No. 7, will be sent to persons interested in water-power development.